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THE GENUS HAPLOZOON, DOGIEL. OBSERVATIONS ON THE LIFE HISTORY AND SYSTEMATIC POSITION *

Waldo Shumway

The genus which forms the subject of this study includes some curious microscopic parasites found in the intestines of certain tube-building marine annelids. The type species, *Haplozoon armatum,* was originally described by Dogiel (1906) as a mesozoon, and for the genus, including the species described later (1908, 1910) he established a new mesozoan class, the Catenata. Soon after the appearance of the original description, Chatton in 1907 pointed out that the forms described presented resemblances to Blastodinium, a parasitic dinoflagellate. Neresheimer (1908) excluded the genus from the mesozoa on the grounds of its protozoan affinities, and Poche (1911) erected a new class of the protozoa, the Haplozooidea, for its reception. Chatton in his memoir on the parasitic dinoflagellates (1920) assigns the genus to the family Haplozoonidae of the suborder Gymnodinida.

Since their description by Dogiel, no further observations on these parasites were made until the appearance of a short note by Calkins (1915) in which he described a similar form from the intestine of *Clymenella torquata* under the name of *Microtaeniella clymenellae,* assigning it from superficial gregarine-like characters to the schizogregarines. Poche (1916) compared the descriptions of Haplozoon and Microtaeniella in detail, coming to the conclusion that the two though distinct genera were closely related. A similar opinion was expressed by Mesnil (1917). Chatton (1920) refers this species to Haplozoon, relegating Microtaeniella to the synonomy.

In 1919 Dr. Calkins suggested the advisability of reexamining these forms, and that summer as well as the one of 1922 was spent in a study of the parasites of Clymenella at Woods Hole, while in 1921 an opportunity of examining one of the European species at Roscoff presented itself. I am indebted to Dr. Calkins for many kindnesses shown me in the course of this investigation, to Prof. Charles Perez, director of the Marine Biological Laboratory of the Sorbonne at Roscoff, for

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laboratory facilities and the identification of the annelids in which parasites were sought, and to Dartmouth College for the use of a room at the Marine Biological Laboratory at Woods Hole.

The simplest method of obtaining material is to dissect out a portion of the intestine of the host and to tease this with fine pointed needles upon a slide, which may then be covered for immediate observation, or a few drops of a fixing fluid added and the slide handled as though sections were attached. Sublimate, with or without acetic acid, Bouin's fluid and Flemming's strong fluid gave good results. Portions of the intestine were fixed, sectioned and stained by many of the familiar methods, and some excellent preparations have resulted from this method. It was not possible to cultivate the parasites in sea water. The method by which the free-swimming stage was obtained will be set forth below.

Eight species of Haplozoon, including those described below, are recorded, each infecting a different host as well as differing from the other in morphological and sometimes in physiological details. A list of species follows with the host and locality of each indicated:

1. armatum, Dogiel, 1906. Travisia forbesi, Bergen, Alexandrovsk.
2. lineare, Dogiel, 1907. Clymene lumbricalis, Alexandrovsk.
3. delicatulum, Dogiel, 1910. maldanid, gen sp?, Trondheim.
4. ariciae, Dogiel, 1910. Aricia norvegica, Trondheim.
5. macrostylum, Dogiel, 1910. maldanid gen?, Trondheim.
6. obscurum, Dogiel, 1910. Terebellides strömii, Trondheim.
7. clymenellae, (Calkins) 1915. Clymenella torquata, Woods Hole.
8. dogieli, Shumway. n.sp. Leiochone clypeata, Roscoff.

In addition Mesnil (1917) notes the occurrence of an undescribed species in the intestine of *Scololepis fulginosa,* and Dogiel (1910) remarks in passing that he has observed several types of Haplozoa in polychaetes at Naples. The genus has a cosmopolitan distribution and representatives may be expected from many other hosts.

Before proceeding to a discussion of the characters of the genus, I shall introduce a new description of *H. clymenellae* to emend the earlier account of Calkins. This will be made a little more complete than is customary in order to review the salient characters of the genus without repeating the description of the type species, *H. armatum,* which is scattered over several papers (Dogiel, 1906, 1907, 1908, 1910). A brief description of the new species, *H. dogieli,* follows.

HAPLOZOON CLYMENELLAE *Chatton* 1920
Syn. MICROTAENIELLA CLYMENELLAE *Calkins* 1915

This species is a colonial parasite of the intestine of *Clymenella torquata,* a maldanid annelid found in the vicinity of Woods Hole, Mass. All stages from the unicellular form to colonies of over 250

cells may be found. The form of the colony may be linear, pectinate or pyramidal, depending on age and environmental conditions. The size varies from 50μ in the unicellular form to over 300μ in large colonies. The trophocyte by which the colony is attached to the intestinal wall of the host is the largest cell of the colony, and is armed with a proboscis in which trichites are embedded. Many other trichites are found in the cytoplasm of the trophocyte. Attachment to the epithelium of the intestine is by means of a sucking disc controlled by numerous powerful myonemes. The actions of the myonemes result in constant changes in the shape of the trophocyte when detached from the host wall. These often result in twitchings of the colony which give the impression of locomotion. From the trophocyte numerous very delicate filaments or rhizoids extend into the cells of the intestinal epithelium. Unicellular forms are of the trophocyte type. The greater part of the colony is made up of gonocytes. Of these the youngest is that next to the trophocyte and formed by the transverse division of the trophocyte. It may be called a primary gonocyte. The others have been formed by the continued divisions of earlier primary gonocytes. Trichites are sometimes found in the younger gonocytes. No intercellular openings are present. The terminal cells of the colony are sporocytes which differ from the gonocytes in their more rounded form, clearer protoplasm, the possession of small rounded inclusions of a higher refractive index, and in the presence of four nuclei. These arise from gonocytes in which two nuclear divisions have taken place without corresponding cell divisions. The sporocytes are easily detached from the colony and fall into the lumen of the intestine. From the anus of the host emerge small cysts averaging 12μ in diameter, which are probably the encysted sporocytes, for these have the same dimensions. From these cysts the dinospores emerge, tiny gymnodinium-like free swimming forms, 12 to 13μ in length by 10μ in diameter. The mobile dinospores reencyst readily and undergo division within the cyst, four daughter dinospores being formed. No division or conjugation has been observed while the dinospore was mobile. Of the previously described species, *H. clymenellae* most closely resembles *H. delicatulum* from which it differs in that the pyramidal type of colony is sometimes found (Figs. 10 and 11).

HAPLOZCON DOGIELI nov. sp.

This species is an intestinal parasite of *Leiochone clypeata,* a maldanid found at Roscoff, Finisterre, France. No colonies larger than thirty-two cells observed. The unicellular form is about 60μ in length and largest at the posterior end. The largest colony measured 150μ. The trophocyte is unusually large as compared to the gonocytes and the long axis is dorsoventral instead of anteroposterior. Many trichites

are found in the trophocyte. The sucking disk and myonemes are unusually large. Rhizoids are present. The colony is linear or pectinate, and no sagittal cleavage planes observed. The sporocytes are quadrinuclear. Dinospores were not discovered. This species differs from *H. delicatulum,* which it most closely resembles, in the large size of the trophocyte and its shape (Fig. 9).

CHARACTERS OF THE TROPHOCYTE

This term is applied to the attaching cell of the colony by Chatton (1920) and corresponds to the "Kopfzelle" of Dogiel (1906) and "primite" of Calkins (1915). The youngest stages of haplozoon development discovered in the host are unicellular trophocytes. This stage has been described by Dogiel (1908) in *armatum* and *lineare.* Figure 8 illustrates the corresponding stage in *clymenellae,* Figure 5 in *dogieli.* The examples of the two latter species are slightly larger than those figured by Dogiel but this is not significant in view of the small number observed. The anterior end of the cell is of a clearer consistency and contains the proboscis which is armed with trichites, more of which, the "Ersatzstiletten" of Dogiel, lie scattered through the cell. The posterior two thirds of the cell, is densely granular and contains a single large nucleus with a karyosome. It is impossible to say whether these unicellular forms were attached as the teasing of the intestine may have torn them from the intestine. They were, however, quite mobile, twisting the anterior end from side to side and writhing forward with a motion not unlike that of a gregarine. I might remark at this point that there is present in Clymenella a coelomic gregarine (*Monocystis clymenellae,* Porter, 1897) which might easily be confused with the unicellular stage of Haplozoon. Stained specimens can be distinguished, of course, by the appearance of the nucleus. In all the unicellular stages of Haplozoon the proboscis was present and in constant activity. The movement, alternate extension and retraction is strong and rapid, and the proboscis easily penetrates epithelial cells and, as I have seen on one occasion, the body of another parasite of the same species.

The division of a unicellular trophocyte to form the primary gonocyte has been witnessed but once, in the case of *dogieli* in the summer of 1921. At this time the trophocyte which I was observing attached itself to a large epithelial cell which was isolated, while the proboscis was driven into the cell with a regular movement. The attachment continued for an hour, by means of the sucking disk so far as I could discover (at this time I had not yet identified the rhizoids). During this time the trophocyte gradually divided into two parts, the larger, about two-thirds, becoming the trophocyte, the posterior third forming

the first primary gonocyte. The constriction of the cell body was preceded by a nuclear division. Camera outlines of the process are shown (Figs. 5, 6 and 7).

The trophocyte of the colony is better known than the unicellular stage. It is always the largest cell of the colony and the most highly differentiated. Measurements from fixed and stained specimens of *dogieli* indicate that the trophocyte is from five to six times larger than the gonocytes.

At the attaching end of the trophocyte is a depression which Dogiel described as the mouth. It is surrounded by the myonemes, and as no cytostome can be demonstrated, I regard it as a sucking disk by means of which temporary adhesion can be effected (Fig. 13). The ectoblast of the cell in this region stains very deeply and sections reveal that it is thicker than the cell membrane elsewhere (Fig. 12). This figure may be compared with one of Chatton's of *Oodinium fritillariae* (1920, fig. 15), where an adhesive disk is seen at the end of a peduncle containing many fibers. I do not insist on a strict homology between these structures, only pointing out that comparable organelles are found in other parasitic dinoflagellates.

The proboscis of the trophocyte is the most striking characteristic of the genus. This structure when fully extended is half as long as the trophocyte and slightly curved. It may be entirely retracted within the trophocyte. It is formed from ectoblast and contains one or more trichites, sharply pointed, thorn-like structures which are best demonstrated after fixation with sublimate, but are also to be seen after fixation with Schaudinn's or with Bouin's fluid. They stain most sharply with iron hematoxylin (Fig. 13). In *clymenellae, dogieli, lineare, delicatulum,* and *macrostylum* many such trichites are found in the trophocyte, while in *armatum, ariciae* and *obscurum* they are found only in the proboscis. Trichites have sometimes been observed in the gonocytes. Dogiel and Chatton, following him, regard the proboscis as an organ of fixation. This can hardly be the case, for I have frequently seen the motion of the proboscis continuing while the colony was so firmly attached that it could not be removed by the suction of a fine pointed pipet. I have no information as to the way in which the trichites are formed as they were present in the youngest stages at my disposal. There is no comparable organ known among the parasitic dinoflagellates, but the peculiar genus Erythropsis Hertwig possesses a retractile prod which, however, contains no trichites (Kofoid and Swezy, 1921). The trichites themselves resemble those found in *Syndinium turbo,* as figured by Chatton (1920, fig. 147).

The third organelle of the trophocyte to be described is a group of fine filaments which Dogiel describes at one time as pseudopodia, and

another as flagella. These emerge from the anterior end of the trophocyte on the side of the sucking disk opposite to that of the proboscis, and enter the epithelial cells of the intestine. Dogiel describes these in detached specimens as contractile and vibratile, I have identified them only in sections of attached forms (Fig. 12) of *clymenellae.* I am unable to demonstrate the opening from which these rhizoids, according to Dogiel (1908), are extruded in the case of *H. armatum.* Nor am I able to trace them back into the protoplasm of the trophocyte. They resemble in many respects the rhizoids of *Oodinium fritillariae* Chatton, *Oodinium* (*Gymnodinium*) *pulvisculus* (Dogiel, 1910), or *Ellobiopsis chattoni* Caullery. No contractile vacuoles are present.

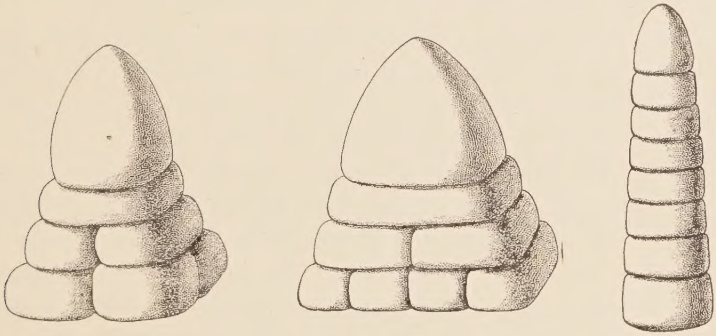
The nucleus of the trophocyte is of the dinoflagellate type, large and with granules of chromatin that stain very faintly with nuclear dyes; a karyosome which on the contrary takes these dyes very strongly accompanies it. The division of the nucleus precedes the division of the trophocyte by some time so that two nuclei are often present. No centrosome has been discovered. A discussion of the phenomena of karyokinesis deferred to a later part of this report.

CHARACTERS OF THE GONOCYTE

This term, as used by Chatton, refers to the cells produced by the division of the trophocyte, prior to their own division. I shall use the term, however, not only for these cells, which I designate as the primary gonocytes, but for all the cells produced by their division, secondary, tertiary, etc., gonocytes, up to the time when the quadrinuclear condition is manifested. Used in this way the term gonocytes becomes equivalent to the "Körperzellen" of Dogiel. Calkins made no distinction between the types of cells formed from the trophocyte, calling them all "satellites."

The gonocytes, then, make up the greater part of the colony, the form of which therefore is conditioned upon the regularity and direction of their divisions. In regular cleavage, the gonocyte divides at about the same time as the trophocyte, so that the young colonies would increase in cell number according to the progression 1, 2, 4, 8, exactly as do fertilized eggs with the regular type of cleavage. Chatton (1920) has devised a formula which may be applied to any of the colonial dinoflagellate parasites which he has described. According to this formula, the letter I represents the trophocyte and to this is added a subscript numeral to indicate the number of times the trophocyte has divided, while the cells resulting from the division of each primary gonocyte are represented by successive numerals of which the first represents the youngest primary gonocyte. So the formula for an eight-cell colony

formed by regular cleavage would be represented as follows: 1_3-1-2-4. The cleavage is not as regular, however, as might be imagined from this account. Colonies of 3, 5, 6 and 7 cells are found frequently. A study of the mitotic figures shows that the cells of the same gonocyte generation are frequently in different stages of mitosis, so that some will have completed their division before others and thus give rise to these intermediate stages. In older colonies it is frequently difficult to apply the formula of Chatton because of the loss of sporocytes from the free end of the colony. The colony in Figure 11, for example, is represented by the formula I_6-1-2-4-8-16-32 or 64 cells. Actually there are only twenty-eight cells in the last group, as four have not completed division. The four terminal cells are sporocytes, an unusually small number for a colony of this size and it is probable that up to thirty-two have been detached.



A B C

Text figure I. Models to represent colony-types: *a*, pyramidal; *b*, pectinate; *c*, linear.

The cleavage planes follow the Sachs-Hertwig rules, but are modified by pressure against the walls of the intestinal folds and what appear to be hereditary factors in the different species. In naming the planes of cleavage, I shall consider the attaching end of the colony as anterior, and the side of the trophocyte on which the proboscis is borne as dorsal, following the terminology of Dogiel. The first cleavage, which results in the production of the first primary gonocyte is transverse in *clymenellae, dogieli, delicatulum* and *lineare*. In the other species it is subtransversal in direction, as are all the other succeeding cleavages which are transverse in the group named above. The second cleavage may be at right angles to the first, in the frontal plane. The third might be at right angles to both these, appearing in the sagittal plane. In this way a colony such as shown in the text-figure *a* might be formed. This type we shall designate as pyramidal, and is with certain modifi-

cations to be described later, characteristic of *clymenellae*, among the species with transverse gonocyte division, and of *macrostylum* and *obscurum* among those with the subtransversal type.

The third type of cleavage (sagittal), however, is seldom found as early as the third division and I have found no colony in *clymenellae* with more than one division of this sort. It has not been observed at all in any species except those mentioned above.

If no sagittal cleavages appear and the third plane of cleavage is frontal like the first there would arise a type of colony which may be called pectinate (Text-figure *b*). This is characteristic of *dogieli*, and *delicatulum* among the species with transverse gonocyte division, or *armatum* among those of subtransversal. Here, again, it is necessary to note that the frontal type of cleavage may not appear till late in colony formation (Fig. 11), and young colonies up to the eight-cell stage of the species mentioned above often do not exhibit it.

Finally all cleavage planes may be transverse even in large colonies. This results in the linear type of colony as represented in Text-figure *c* which is characteristic of *lineare* among the species with true transverse division, of *ariciae* among those with subtransversal.

Enough has been said to show that colonies only approximate the form of the type. Often on the same slide parasites as divergent in form as those represented in Figures 10 and 11 are to be seen. The explanation for this probably lies in the fact that the trophocyte is attached in one of the folds of the intestine and the changing pressure exerted by the sides of the fold on the dividing gonocytes bring about the variations in form of the colonies.

The gonocytes possess neither proboscis, myonemes nor rhizoids. Trichites are sometimes found in the gonocytes of latest formation, probably carried over from the trophocyte in the process of cell division. As they do not appear in the older gonocytes it is possible that they have been resorbed. Dogiel (1910) describes and figures rhizoids in *obscurum* extending into the primary gonocyte, but usually these terminate within the boundaries of the trophocyte, and I have not seen them elsewhere in *clymenellae* nor *dogieli*. Nor have I found any trace of the intercellular openings between the gonocytes and the trophocyte as described by Dogiel (1910) in the species, *armatum, ariciae,* and *obscurum*. These enigmatic openings according to the discoverer of the genus are caused by the persistence of what he calls "Verbindungs-chromosomen," but which appear to me after an examination of his figures to be centrodesmoses remaining from the spindle (Fig. 14). It is of interest to note here that the absence of the intercellular openings, the possession of many trichites, and (with the exception of

macrostylum) transverse division of the gonocyte, characterize the species which parasitize members of the Maldanidae, while the opposite statements are true of the parasites found in other families.

Usually a single nucleus is present and this is almost always in the process of karyokinesis (Figs. 14-16). In colonies which have been detached some time from the host the nucleus may assume the resting appearance in which it much resembles the dinoflagellate type. Not infrequently two nuclei are present in anticipation of the coming cell division. The terminal gonocytes regularly have two nuclei; these will divide again without cell division to form the sporocytes.

CHARACTERS OF THE SPOROCYTE

I shall apply this term to the terminal cells of the colony which were called "Urgeschlechtszellen" by Dogiel in his memoir of 1910. These cells differ from the gonocytes first in their shape which is more rounded and gives them the appearance of larger size. In reality their mass is about the same, sporocytes in *dogieli* and *clymenellae* having a diameter of from 11 to 13μ, gonocytes in the same species averaging in large colonies from 6 to 8μ in length, 12μ in breadth, and 15 to 20μ in depth.

In the living colony the sporocytes appear more opaque than the gonocytes, owing to the presence of numerous rounded inclusions which I have not been able to identify. In fixed specimens, particularly after acetic acid, these inclusions are washed out and the sporocytes are more transparent than the remainder of the colony.

Perhaps the most striking characteristic of the sporocyte is the nuclear number. Four nuclei, much smaller than those of the gonocyte, appear, and all stages intermediate are often found which show that the sporocyte arises from a gonocyte in which two nuclear divisions have taken place without cell division. These nuclei are characterized by the absence of a karyosome, by the intenseness with which the nuclear stain is taken up and the compactness of the chromatin (Figs. 17-20). No evidence for the cell division of the sporocyte while attached to the colony has been found in the hundreds of specimens I have examined.

The appearance of sporocytes does not depend on the number of divisions of the primary gonocyte. Sporocytes are found in colonies of as few as eighteen cells in *armatum, dogieli,* and *clymenellae,* and, on the other hand, large colonies of upwards of two hundred and fifty cells have been recorded in which only the terminal cells, between eight and sixteen in number, have been transformed. An additional clue is seen in the conditions in *armatum,* where the subtransversal character of the primary gonocyte division, brings together as terminal cells, units from different files, i. e., different gonocyte generations. Apparently

then the production of sporocytes depends not on the number of gonocyte generations nor the distance from the attaching trophocyte. A possible explanation may lie in the way in which the colony is attached to the intestine. A colony lying in a shallow fold would grow into the lumen of the intestine after fewer gonocyte generations than one which lay in a deeper depression. The hypothesis that the terminal cells become transformed into sporocytes on growing out into the open intestine seems at least a suggestive one.

Owing to their rounded form, the sporocytes are able to move over each other easily, which accounts for their irregular arrangement in large pyramidal colonies such as those of *obscurum* and *macrostylum*. They are also easily detached from the colony to fall into the lumen of the gut. Their further history within the body of the host has not been worked out, as they are difficult to distinguish in smears or sections. Evidence of another kind, however, renders it probable that they encyst and are expelled from the anus with the faeces.

CHARACTERS OF THE DINOSPORES

The further history of the sporocytes was unknown to Dogiel and the statement by Chatton (1920:275), "Il s'est contente de remarquer qu'elles ont au moment de leur mise en liberte l'aspect de petits *Gymnodinium*," is apparently occasioned by the passage in Dogiel (1910:435) " . . . erinnern ihrem Aussehen nach an kleine *Gymnodiniaceae*," which has to do, however, not with Haplozoon, but with the spores of *Oodinium* (*Gymnodinium*) *pulvisculus*, described in the same paper. But Chatton, who has since 1907 maintained that Haplozoon was related to the dinoflagellates, prophesied in 1920 that the spores of Haplozoon when discovered would be of the Blastodinium type. It is a pleasure to be able to announce the fulfilment of this brilliant prediction.

In the summer of 1922, after attempting vainly to maintain the parasites in culture media, a number of Clymenellae from a locality where the worms were almost invariably parasitized, were washed in 70 per cent. alcohol until anaesthetized, followed by repeated changes of sea water which had been boiled for ten minutes and restored to the original volume by the addition of distilled water. Finally the worms were left over night in small culture dishes of the sterilized sea water. Two of the six worms treated recovered, and in the culture dishes were found swimming about small flagellates resembling gymnodinia in their movement (Fig. 1).

A more detailed examination revealed the fact that these tiny organisms resembled very closely the mobile dinospores of Oodinium, Apodinium and Blastodinium as described by Chatton. The dinospore

of Haplozoon measures approximately 12μ in length and 10μ in greatest diameter. That of *Blastodinium spinulosum* according to Chatton is 13μ in length, 10μ in diameter, and the only measurement recorded for *Oodinium poucheti* is 11μ. The form is nearly oval, with the epicone rounded and slightly larger than the hypocone. The girdle is subequatorial, slightly helicoidal, narrow and deep. The sulcus is wider and more shallow. The transverse flagellum is large and contained entirely within the girdle. The longitudinal flagellum tapers off to a delicate point and is about twice the length of the body. The insertions of the two are together at the point where the girdle and sulcus join. The blepharoplasts were not observed. No ocular apparatus nor pigment was found. The cytoplasm contains many rounded granules of some refringent material resembling those of the sporocyte. One, two and four nuclei could be faintly observed in the living specimens.

When treated with acid methyl green the dinospore becomes more rotund, the furrows disappear and if the flagella are in a favorable position it can be seen that they are similar and equal in length. The refringent bodies take the stain sharply as does the nucleus. In the specimens so treated one or two nuclei only were observed and in these the appearance was that of a large oval body with fine striations of chromatin granules and no karyosome. When fixed with Schaudinn's fluid and stained with Heidenhain's hematoxylin and magenta red, all external characters vanished and the cytoplasm was highly vacuolated. One, two and four nuclei were observed, and in one specimen there appears to be a mitotic figure (Fig. 21).

While studying these dinospores it was discovered that they encysted with extreme rapidity, the process taking only a few seconds and often at a most inconvenient time for the observer. A search of the culture media revealed the presence of many of these cysts in the bottom of the dishes, and closer examination showed that they contained not only one but two or four individuals. The cysts averaged about 12μ in diameter and were very thin walled. Within them the dinospores twisted and turned with great lability. Figures 2, 3 and 4 illustrate encysted dinospores of the one, two and four cell stage prospectively. In order to determine whether the dinospores were reproducing by fission, counts of the individuals, mobile and encysted, were made and it was found that the numbers increased rapidly over night. Fixed and stained preparations (Figs. 22-25) show that mitosis is taking place within the cyst walls. No evidence of division of the mobile dinospores was found. The experiments were repeated and new cultures of dinospores obtained. Both sets were continued for some two weeks before I was called from the laboratory. No conjugation was observed.

No attempts were made to reinfect *clymenellae* by means of these dinospores, owing to the impractibility of obtaining uninfected material. Practically every worm dissected or sectioned has contained parasites. Attached colonies are found from a point posterior to the crop to the beginning of the rectum. All stages from the unicellular to the largest colonies may be found in a single individual or in a single preparation. These conditions point toward a continuous reinfection in small numbers, such as would be the case if the worm ingested the dinospore cysts, as these fall continually on the sands in which the worm lives.

The question now arises as to the rôle of the dinospore in the life history of Haplozoon. Chatton interprets the corresponding stage in Blastodinium and its allies as a gamete. The evidence I have presented would tend rather to show that the dinospore represents a free-living, sexual (?) stage reminiscent of the ancestral Gymnodinium, while the colony may be thought of as the attached, parasitic, asexual generation. The dinospore generation reproduces by fission within a cyst wall, often producing four individuals at a time; the trophocyte generation reproduces by unequal division (almost budding), giving rise to a somatella of gonocytes of which the terminal cells become transformed into sporocytes, which are detached, encysted and later evacuated by the host. Conjugation of dinospores has not yet been observed in the many parasites studied by Chatton, and the phenomenon is indeed little known in the free-swimming dinoflagellates.

KARYOKINESIS

The nucleus of Haplozoon is continually dividing, often at such a rate that nuclear division is complete before the onset of cytoplasmic division. In *dogieli,* the presence of two nuclei is the rule rather than the exception, even in the trophocyte, and the presence of two or four nuclei in the sporocytes is to be explained by this acceleration of karyokinesis which is also found among other parasitic dinoflagellates. Chatton looks on this as one of the characteristics imposed by the parasitic habit. However this may be, the accelerated rate of mitosis might be expected to make these forms unusually favorable for the study of this phenomenon. Mitotic figures are indeed frequent, but the diverse effects produced by different fixatives give widely differing pictures. Dogiel reported (1908) that Flemming followed by safranin gave the best results in total preparations, while sublimate acetic gave the best fixation for sections stained with iron hematoxylin, Carnoy followed by hematoxylin and eosin also gave useful pictures. Later he tells us that the safranin gives the best results on chromatin, picrocarmine or Delafield's hematoxylin on the caryosome, eosin for the pole spheres, and iron hematoxylin for "Zugfasern" and centrosome.

I have found that either sublimate acetic or Bouin's fluid followed by iron hematoxylin gave as good pictures of the chromatin as the Flemming-safranin method, while one of my best preparations is made by the Cajal (magenta-red followed by picro-indigo-carmine) stain of sublimate-acetic fixed material. The pole spheres did not stain well with the eosin I used, and show best in figures which are not sufficiently destained for the chromatic elements. The so-called "Zugfasern" appear only after fixatives without acetic acid. Centrosomes were found only in Bouin fixed material.

In general, the phenomena of mitosis resemble those described by Calkins in Noctiluca (1895). Between mitoses the nuclei are of the typical dinoflagellate type, large and with the extremely fine granules of chromatin arranged in delicate lines which give a striated appearance to the whole nucleus. Between the nuclei of the trophocyte and those of the terminal sporocytes a gradual transition takes place. The chromatin in the trophocyte is in the form of scattered, extremly fine granules, of which a large number is present. In the sporocytes the chromatic material is condensed so that there are fewer granules, larger and more deeply staining. In the trophocyte also the karyosome is larger, while in the sporocyte it cannot be recognized. It is difficult to avoid the conclusion that in Haplozoon the karyosome is a reservoir of chromatin which is utilized during the subsequent mitoses. Here it may be remarked that the nucleus of the Blastodinium trophocyte is also stained lightly by basophilic dyes, while it contains not one but several masses which stain intensely with these dyes like the karyosome referred to above. These masses appear also in the sporocytes formed from the later gonocytes, but have disappeared in the older generations.

The division center is a pole sphere which I have been unable to identify except in dividing nuclei. In these the achromatic material has the form of a dumb-bell, of which the shaft is usually curved, around which the chromosomes form a C-shaped mass (Fig. 15). In the gonocytes the individual chromosomes, well over a hundred in number are long delicate threads (Figs. 14, 15). In the sporocytes they are short and compact and approximately a quarter that number, their small size precluding an accurate count (Figs. 19, 20). From the figures given by Chatton they resemble those of *Blastodinium* very closely. I have been unable to determine whether the division of the chromosomes is transverse or longitudinal. But during the anaphase the two masses of chromatin move toward the two pole spheres along the shaft of the achromatic figure. This shaft persists after division is complete in some species, according to Dogiel, and produces the intercellular openings characteristic of *armatum, ariciae* and *obscurum*. I have been able to identify the centrosome only in a few of the mitotic

figures I have examined (Fig. 18), and Dogiel states that he could find them in only a few instances. These cases were all in sporocytes, while in Blastodinium they are found only in the trophocyte.

The "zugfasern" of Dogiel I find only in material fixed in sublimate without acetic acid (Fig. 16). These trident-shaped bodies, according to Dogiel, represent the fused ends of the spindle fibers which are too thin to distinguish. From the fact that they are washed out by acetic acid it appears more plausible to regard them as archoplasmic inclusions of the same nature as the Golgi bodies.

The dinospores are extremely difficult to prepare for detailed observation, not only on account of their small size, but because their protoplasm goes to pieces so rapidly that a proper fixation is almost impossible. Figure 21 gives an idea of the appearance of a dinospore fixed and stained with hematoxylin, the vesicular nature of the cytoplasm, the inclusions and, at x, what appears to be a mitotic figure, with centrosomes and a centrodesmose. The encysted spores are not quite so refractory, however, and in Figure 23 we see an example of the type of mitosis found in the colony, with the two pole spheres and mass of closely packed dark-staining chromosomes around the shaft connecting them.

SYSTEMATIC POSITION

The reader who is interested in the comparison of Haplozoon with many types of protozoa and mesozoa will find these in the memoirs of Dogiel. They are now of historical interest only, for this review of the material shows that the closest affinities of the genus are with Blastodinium as has been claimed by Chatton. Both are intestinal parasites, whose life history commences as a unicellular trophocyte, which gives rise by successive divisions to gonocytes which remain in association with the trophocyte to form a somatella; these gonocytes dividing in their turn ultimately become transformed into sporocytes, which leave the host encysted, but in the sea become liberated as gymnodinium-like dinospores. The essential difference between the two lies in the fact that the development of the parasitic stage of Blastodinium takes place within a cyst wall, while that of Haplozoon is not protected in this way. In Haplozoon, then, one finds attaching organs, such as the sucking disk and the rhizoids, which I have shown elsewhere are comparable to the attaching organs of ectoparasites, such as Oodinium, and the proboscis, of problematic function, neither of which is represented in Blastodinium. The resemblance of these forms in nuclear phenomena is especially striking. The binuclear and quadrinuclear condition is frequent in both. The details of mitosis, which is of the Noctiluca type in both genera, cannot be overlooked. Finally the resemblance of the

newly discovered dinospores of Haplozoon to those of Blastodinium removes the last difficulty in comparing the two genera. I follow Chatton, then, in assigning Haplozoon to the Gymnodinida as a single genus representing the family Catenata (Dogiel) 1906.

KEY TO THE SPECIES

The eight species of Haplozoon listed in the introduction fall into two groups which may be considered provisionally as subgenera with the following characteristics:

A. Many trichites in trophocyte. Division-plane of primary gonocyte usually transverse. No intercellular openings. Parasitic in Maldanidae.

1. Linear type of colony only. *H. lineare.*
2. Linear and pectinate colony types. Long axis of trophocyte anteroposterior. *H. delicatulum.*
3. Linear and pectinate colony types. Long axis of trophocyte dorsoventral. *H. dogieli.*
4. Linear, pectinate and pyramidal colony types. Gonocyte division plane transverse. *H. clymenellae.*
5. Linear, pectinate and pyramidal colony types. Gonocyte division plane sub-transverse. *H. macrostylum.*

B. One trichite only, in proboscis. Division-plane of primary gonocyte subtransverse. Intercellular openings present. Parasitic in families other than Maldanidae.

6. Linear type of colony only. *H. ariciae.*
7. Linear and pectinate colony types. *H. armatum.*
8. Linear, pectinate and pyramidal colony types. *H. obscurum.*

SUMMARY

The genus Haplozoon Dogiel (1906) is reviewed. The similar form *Microtaeniella clymenellae* Calkins (1915) is redescribed and found to be a species of Haplozoon. A new species *H. dogieli* is described. On the basis of these investigations the morphological characteristics of the genus are revised, and the species divided into two groups of subgeneric value. The existence of a free-swimming gymnodinium-like stage in the life history is demonstrated, and evidence brought forward to show that this represents a free-swimming sexual generation rather than gametogenesis. A comparison of the genus with the parasitic dinoflagellates described by Chatton, especially in regard to the details of mitosis, confirm's that writer's contention that Haplozoon should be placed with them in the suborder Gymnodinida.

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Explanation of Plate XV

All figures redrawn from camera lucida sketches of the living specimens.

Fig. 1.—*H. clymenellae*. Free-swimming dinospore. × 2000.

Fig. 2.—*H. clymenellae*. Encysted dinospore before division. × 2000.

Fig. 3.—*H. clymenellae*. Encysted dinospore. First division. × 2000.

Fig. 4.—*H. clymenellae*. Encysted dinospore. Second division. × 2000.

Fig. 5.—*H. dogieli*. Unicellular trophocyte attached to isolated epithelial cell of intestine. × 450.

Fig. 6.—Same after five minutes. First primary gonocyte division.

Fig. 7.—Same after five minutes.

Fig. 8.—*H. clymenellae*. Unicellular trophocyte. × 450.

Fig. 9.—*H. dogieli*. Colony with trophocyte, gonocytes and terminal sporocytes. The trophocyte is shown contracted (in stipple) and expanded (in dotted outline). × 450.

Fig. 10.—*H. clymenellae*. Large pectinate colony. × 450.

Fig. 11.—*H. clymenellae*. Large pyramidal colony. First row cells only indicated. × 450.

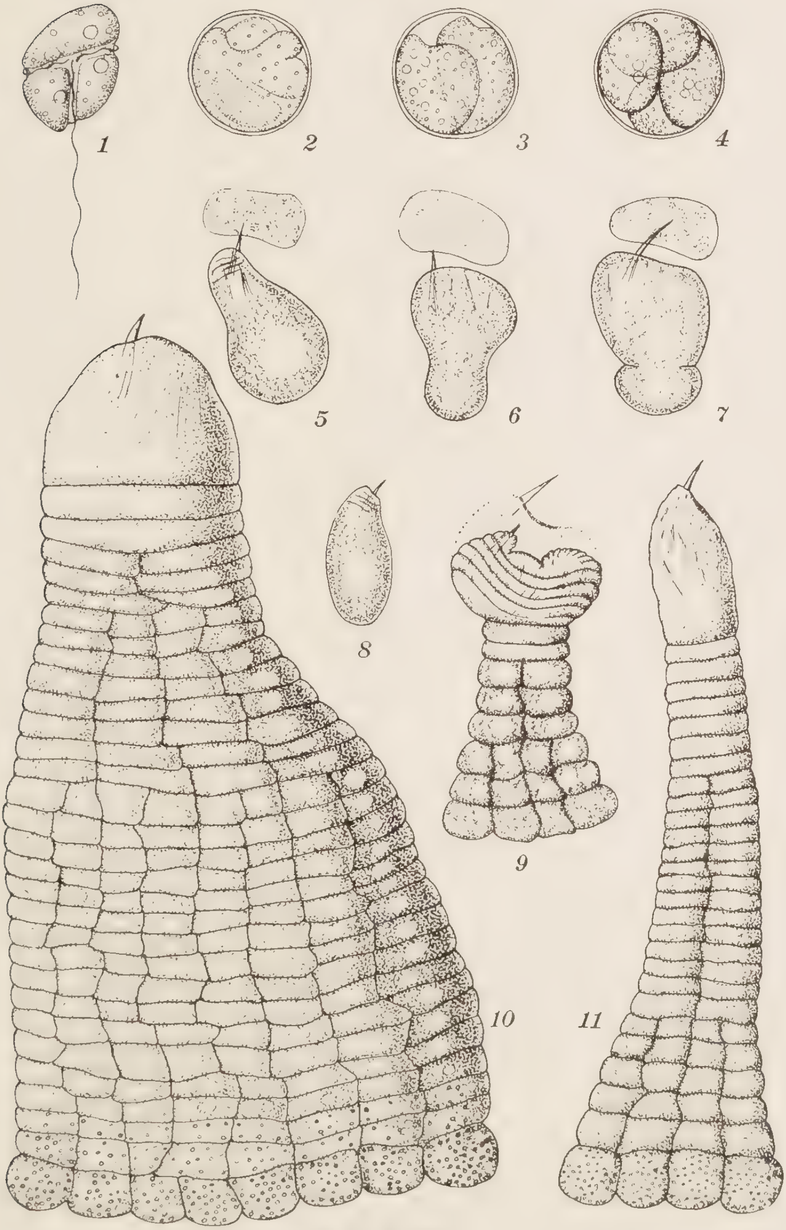


PLATE XV

Explanation of Plate XVI

All figures drawn from permanent preparations with camera lucida. × 2250.

Fig. 12.—*H. clymenellae.* Sagittal section 5μ, Zenker. Iron-hematoxylin, Orange G. Trophocyte showing two nuclei, proboscis and rhizoids extending into wall of intestine. The attaching disk is stained a deep black.

Fig. 13.—*H. dogieli.* Total preparation. Bouin. Iron-hematoxylin. Trophocyte showing two nuclei, proboscis, numerous trichites, attaching disk, and myonemes.

Fig. 14.—*H. clymenellae.* Total. Schaudinn. Iron-hematoxylin. Anaphase in gonocyte showing two pole-spheres, karyosome divided, chromosome groups separated, centrodesmose.

Fig. 15.—*H. clymenellae.* Total. Flemming. Safranin. Metaphase in gonocyte showing central shaft of achromatic figure, two pole spheres (faintly), chromosomes in C-shaped mass around shaft, nuclear membrane.

Fig. 16.—*H. clymenellae.* Total. Sublimate without acetic. Iron-hematoxylin. Anaphase in gonocyte showing the so-called "Zugfasern" of Dogiel.

Fig. 17.—*H. clymenellae.* Total. Bouin. Iron-hematoxylin. Sporocyte just prior to quadrinuclear stage. In the upper half of the cell are the two daughter nuclei of one division in the beginning telophase. Below the mitotic figure is in the late anaphase. The polar spheres are indicated faintly.

Fig. 18.—*H. clymenellae.* Total. Bouin. Iron-hematoxylin. Sporocyte. The quadrinuclear stage just attained. The chromosome masses are cupped around the pole-spheres. In the lower pole-spheres, centrosomes are apparent.

Fig. 19.—*H. clymenellae.* Total. Sublimate-acetic. Cajal's stain. Sporocyte. Four nuclei in telophase. Chromatin in granules.

Fig. 20.—*H. clymenellae.* Total. Flemming. Safranin. Sporocyte. Four nuclei in resting stage. Chromatin in threads.

Fig. 21.—*H. clymenellae.* Total. Sublimate-acetic. Iron-hematoxylin Orange G. Mobile dinospore. A poor preparation, introduced only to show the mitotic figure apparent at x.

Fig. 22.—*H. clymenellae.* Total. Sublimate-acetic. Iron-hematoxylin. Encysted dinospore with single nucleus.

Fig. 23.—Another individual in mitosis.

Fig. 24.—Another individual with two nuclei.

Fig. 25.—Another individual with four nuclei.

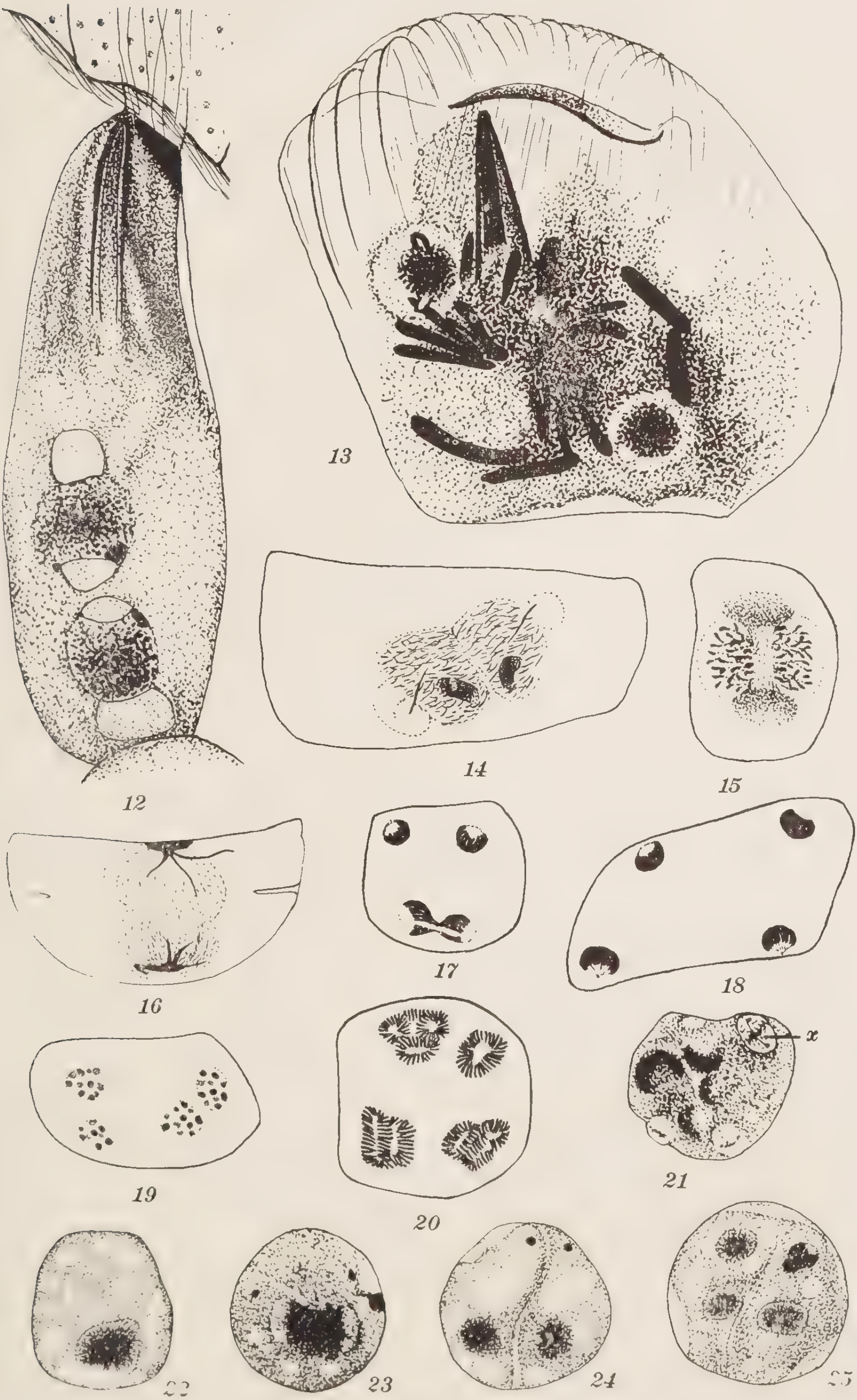


PLATE XVI

GIARDIA AND CHILOMASTIX FROM MONKEYS, GIARDIA FROM THE WILD CAT AND BALANTIDIUM FROM THE SHEEP *

ROBERT W. HEGNER

Among the most interesting of the intestinal flagellates are the species belonging to the genus Giardia. Careful studies of the size and shape of the body, of the nuclei, and of the parabasal bodies, and the size and internal structure of the cysts indicate that a very high degree of specificity with respect to hosts exists within this genus. The following have been described as distinct species: from mammals, (1) *Giardia lamblia,* from man; (2) *G. muris* from rats and mice; (3) *G. microti,* from field mice; (4) *G. duodenalis,* from rabbits; (5) *G. canis,* from dogs; (6) *G. caviae,* from guinea-pigs; (7) *G. pitymysi,* from field mice; (8) *G. viscaciae,* from the viscacha; and possibly others from cats and sheep; from birds; (9) *G. sanguinis,* from the falcon; (10) *G. ardeae,* from the heron, and possibly two other species from the red-backed shrike and the avocet; (11) *G. varani,* from the lizard (*Varanus niloticus*); and from the tadpoles of frogs, (12) *G. agilis.* The writer and his colleague, Dr. C. E. Simon, have examined the species listed above as numbers 1 to 6, and 12, and feel certain that they are distinct species. The others, numbers 7 to 11, have not been so carefully studied and their specific rank is still to be established (Simon, 1921, 1922; Hegner, 1922, 1923).

GIARDIA CYSTS FROM THE MONKEY (Fig. 3)

These were obtained from the feces of a young South American monkey, *Ateleus geoffroyi* Kuhl, purchased in a Baltimore animal store. So far as known to the writer this is the first record of the infection of this monkey with giardia. No trophozoites were found either in the feces or in the duodenum of this monkey when it was killed after being kept in the laboratory for six weeks. The cysts are obviously different from those of *G. lamblia.* The results of measurements are given in the following table.

Measurements, in Microns, of Giardia Cysts from Man, Monkey and Wild Cat

Origin of Cysts	Number Measured	Length			Breadth			Ratio Length to Breadth
		Lowest	Highest	Mean	Lowest	Highest	Mean	
Man *	250	8.00	14.00	10.70	6.00	10.00	7.47	1.43
Monkey	100	11.01	14.40	12.69	6.77	9.31	7.76	1.64
Wild cat	50	11.01	13.55	12.40	6.77	8.47	7.88	1.57

* After Simon (1922: 431).

* From the Department of Medical Zoology, School of Hygiene and Public Health, the Johns Hopkins University.

The principal difference between the cysts from man and monkey indicated by these measurements is the greater minimum length and average length of the cysts from the monkey; this gives these cysts a more slender appearance than those from man. The size and shape of giardia cysts do not differ in the different species as much as do th trophozoites. It seems quite probable, therefore, that the giardia in this monkey is a species distinct from that of man.

GIARDIA CYSTS FROM WILD CAT, *Lynx ruffus* (Fig. 4).

These cysts were discovered during the examination of feces from carnivorous animals in Druid Hill Park, Baltimore. They were noted on only one occasion. Measurements, as indicated in the table show them to be almost exactly of the same dimensions as the cysts obtained from the monkey. No trophozoites were secured. On the basis of the data available it is impossible to state whether this is a new species or not.

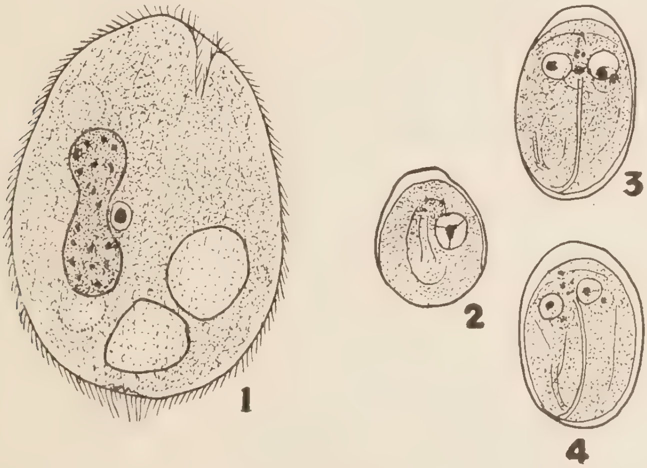
CHILOMASTIX CYSTS FROM SOUTH AMERICAN MONKEY, *Cebus apella* (Fig. 2)

Chilomastix mesnili was first reported from man by Davaine in 1854, who called it *Cercomonas hominis* var. 1; but was not recognized as a distinct species until 1910 (Davaine, 1854, Wenyon, 1910). The first species reported from animals was *C. caulleryi* by Alexeieff in 1909 from tadpoles. Since then species have been described from fish, *C. motellae,* guinea-pigs; *C. intestinalis,* rats; *C. bittencourti,* rabbits; *C. cuniculi,* goats; *C. caprae,* and the leech, *C. aulastomi* (see Hegner and Taliaferro, 1924). So far as known to the writer Chilomastix has not heretofore been recorded from primates. Cysts of a Chilomastix were obtained from the feces of a South American monkey in Druid Hill Park, Baltimore. They resemble cysts of *C. mesnili* from man in shape but are significantly larger. Cysts of *C. mesnili* range from 7 to 9μ in length and from 4 to 6μ in breadth. Those from the monkey measured from 8.47 to 10.26μ in length and from 5.92 to 7.62μ in breadth. No peculiarities in the structure of the cysts were noted.

BALANTIDIUM FROM THE SHEEP

Seventeen different species of intestinal ciliates have been recorded from sheep (Buisson, 1923) but this list does not include any members of the genus Balantidium. This genus is especially common in pigs in which, according to the recent work of McDonald (1922) there are two species, *B. coli* and *B. suis*. *B. coli* occurs rarely in man. Several other species have been reported from man but are of doubtful validity. Primates are occasionally infected; the literature contains records from

the monkeys, *Macacus cynomolgus* and *Cebus variegatus*, from the baboon, and from the orangutan. Other species of Balantidium occur in horse, frog, salamander, fish, snails, cockroaches, flat worms, and coelenterates. The size of the specimens obtained from the pig and man vary considerably. *B. coli* from the pig ranges from 30 to 300μ long and from 20 to 70μ broad with an average length of 86μ, an average breadth of 66μ, and an average ratio of length to breadth of 1.30. The specimens from man range from 30 to 200μ more in length and from 20 to 70μ in breadth; the usual range in size is 50 to 70μ long by 40 to 60μ broad.



Text Fig. 1.—Balantidium from sheep. $\times$ 1125. Fig 2. Chilomastix cyst from a South American monkey, *Cebus apella*. Fig. 3. Giardia cyst from a South American monkey, *Ateleus geoffroyi* Kuhl. Fig. 4. Giardia cyst from a wild cat, *Lynx ruffus*. (Figs. 2-4, $\times$ 2250.)

The specimens of Balantidium from the sheep varied comparatively little in size, and measurements of ten specimens were considered adequate for the present report. These ranged from 40 to 49μ in length and from 29 to 36μ in breadth. The average length was 45, the average breadth 33μ, and the average ratio of length to breadth was 1.36. The shape, as indicated in figure 1, is similar to that of other balantidia. A funnel-shaped peristome is located at one side near the anterior end and an excretory pore is present near the posterior end. The macronucleus is large and kidney-shaped, and suspended in its substance are many rather large irregular-shaped masses of chromatin; these, however, are not constant in size and number as was the case in certain balantidia recently reported from a South American monkey (Hegner and Holmes, 1923). The micronucleus lies in the

concavity of the macronucleus. Many specimens contained large vacuoles besides the two contractile vacuoles.

The data presented above indicate that the balantidia from the sheep are very much smaller than *B. coli* from man and the pig but of approximately the same shape. They differ in shape from *B. suis* from the pig and from the balantidium from the monkey, being much broader in comparison to their length (ratio of length to breadth in *B. coli* of the pig is 1.30, in *B. suis* 1.99, in the monkey balantidium 1.75, in the sheep balantidium 1.36). The macronucleus resembles that of *B. coli* and of the monkey balantidium, and is more massive than that of *B. suis;* it is usually not so sharply bent as in *B. coli.* Only a more detailed study can settle the question of specificity of these mammalian balantidia.

SUMMARY

Cysts of giardia are reported for the first time from a monkey; they are more slender than those of *Giardia lamblia* from man and probably represent a new species. Cysts of giardia are also reported for the first time from the wild cat; they are similar in size to those in the monkey. Cysts of a chilomastix are reported for the first time from a monkey; they are significantly larger than those of *Chilomastix mesnili* from man. A balantidium is reported for the first time from sheep.

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MOSQUITO BREEDING IN SPECIFIC PLACES[1]

WILLEM RUDOLFS

Biochemist in Entomology, N. J., Agricultural Experiment Station

In the course of a study to ascertain the reasons why mosquitoes avoid certain areas although these areas are apparently suitable for breeding and to find out why mosquitoes of various species show preferences for different kinds of breeding places, some general facts are brought out which may be worthy of recording.

Samples of water were taken in three definite areas which had been for years under more or less regular observation by practical mosquito exterminators, inspectors of mosquito commissions, etc. Two areas comprised acid cedar swamp regions; the third area, one where clay is dug for ceramic purposes. One cedar swamp area is located in Burlington county and the water is used by cranberry growers for flooding their cranberry bogs. The great cedar swamp region is found in Cape May county (southern part of state), while the clay pits are found in Middlesex county about in the center of the state.

Drainage in the swamp regions is good except at the heads of the streams and bordering parts of their courses. The soil of the cedar swamp regions is sand to sandy loam, with peat and partially decayed organic material on top, while the clay pit region is blue clay with red shale on top. In the cedar swamp regions the native forest consists mainly of cedars, pine and oaks (mainly black). The undergrowth is abundant except in some places where the cedar and pine stand is so thick that almost no light can penetrate. The undergrowth consists mainly of huckleberry, cranberry, mountain laurel, bracken, greenbrier, staggerbush, wintergreen, sandwort and holly. Fern is abundant in depressions and the lower imperfectly drained situations, and sphagnum moss is plentiful in the swamps. Azalea is common on the wet lands.

In the Whites bog cedar swamp region (Nos. 1-7) samples were taken from furrows on old cranberry bogs; drainage ditches (fast flowing and semistagnant) and swamp streams. In stagnant and semistangant water larvae of *Aedes sylvestris, Culex pipiens, Aedes territans* and *Anopheles* were found; no breeding in fast streaming water.

The great cedar swamp region (Nos. 27-36) is drained by two main creeks. Samples were taken in the middle of the swamp, following the streams out into the open salt marsh meadows.

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[1] Paper No. 188 of the Journal Series, New Jersey Agricultural Experiment Stations, Department of Entomology.

In the clay pits (Nos. 21-26) samples were taken from old abandoned pits and new, working pits. Aquatic animals and plants in most cases totally absent.

In the three regions a number of places were selected for their presumed critical importance. The water samples were analyzed for Ca, Mg, Fe, Al, SO_4, Cl, NO_3, CO_2, tannin, and humic acids. Relative color of the water was scored. Hydrogen-ion concentrations were determined colorometrically in duplicates, directly at the place where the samples were taken and again in the laboratory. Only slight differences occurred between those two determinations. Chemical analyses were made according to the official methods of the American Public Health Association.

GENERAL RESULTS

Chemical analyses were made in an effort to find (*a*) the cause for the acidity and alkalinity of the water samples and (*b*) a possible correlation between the chemical constituents, animal and plant life and mosquito breeding.

From the analyses it was apparent that the acidity of the cedar swamp regions is caused by the total carbonic acid and the humic acids. Only small amounts of sulfates were found. Chlorides were found in appreciable quantities where the creeks and canals are subject to tide. The average P_H for the bog water in the Whites bog region (approximately 300 samples) is P_H 4.5, while the average P_H for bog soils (about 300 samples) is 4.05. Apparently the humic acids are neutralized (fixed or directly precipitated) by products from the decomposition of organic materials. The acidity of the clay pits was clearly due to aluminum and iron sulfates and in some cases also to carbonic acid.

The flora and fauna of the samples from the different regions is given in condensed form in table 1.* The numbers in the first column are sample numbers; the roman ciphers in front of the animal and plant groups indicate their relative abundance regarding each other and the figures in parenthesis after the names represent the numbers of genera.

From the data in the table it seems that with a decrease of acidity the flora and fauna increase. When life increases there seem to be decreasing amounts of CO_2, but when a certain limit is reached, microscopic plant and animal life increases both in numbers and kind to such an extent that CO_2 increases again. Simultaneously with the increasing CO_2 content, the amounts of humic acids decrease. The decrease or fixing of the humic acids might make conditions for life better.

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*I am indebted to Mr. James B. Lackey, protozoologist of the Sewage Substation, for examination and identification of the organisms present in the samples.

TABLE 1.—*Animal and Plant Life in Natural Waters*

No.	*Plants*	*Animals*
	Whitesbog Cedarswamp Region	
1	Practically none; few diatoms	Protozoa (5) (small flagellates very abundant); Rotifers
2	Diatoms; Spirogyra; Desmids	Protozoa (5); not much life
3	Diatoms (10) very abundant; Red algae (1); Green algae (5)	Protozoa (3) few; Rotifers; Cladocera
4	Diatoms-several; Green algae (2)	Small flagellates; animal life scarce
5	Diatoms (15); Desmids (6); Other green algae (6); Blue green algae (6)	Protozoa (7)
6	Desmids (16); Other green algae (9); Diatoms (17); Blue green algae (3)	Protozoa (17); Rotifers; Fairy shrimps; Nematode worms
7	None	Protozoa-few; (small flagellates)
	Great Cedarswamp Region	
27	None	Protozoa (2)
28	None	None
29	Green algae (3)	Protozoa-few; (dinoflagellates)
30	None	Protozoa (2)
31	Diatoms-few	Protozoa (2)
32	None	Protozoa-few; (small flagellates)
33	Diatoms (5)	Protozoa (6); Rotifers
36	Diatoms (3); Blue green algae (1)	Protozoa (9); Copepods; Nematode worms
	Clay Pits	
21	Diatoms, many Green algae (5); Blue green algae (1)	Protozoa (6); Daphnia; Rotifers
22	Diatoms, few; Green algae (3)	Protozoa (4); Daphnia; Rotifers
24	Fungus (1)	Protozoa (4)
25	None	Protozoa-few; (small flagellates) Rotifers-few
26	Diatoms (4)	Protozoa (6)

A perusal of all data obtained and of the notes show that mosquito breeding in Whites bog region seems to be limited to stagnant or semi-stagnant water. Breeding occurred in No. 1 and not in Nos. 2, 3, 4 and 7. Acidity (P_H 4.2) or chemical composition does not seem to be the limiting factor. Food supply was also not the limiting factor since more life was found in No. 3 than in No. 1. (A 10 gallon sample of bog water collected from a stagnant drainage ditch, with a P_H of 4.5 was on April 6 swarming with larvae of *Aëdes canadensis.*)

In the great cedar swamp region no breeding is found in the interior. The food supply is very scant. Ditches subject to tide do not breed mosquitoes on account of limited food supply, fish and streaming of the water. In undrained places food supply increases, provided sufficient light can penetrate the thick forest or undergrowth. Sterility of the water decreases when streamlets come out in the open. With the increase of food supply mosquito breeding increases.

In the clay pits little life is found. This stagnant water is high in aluminum sulphate and iron sulphate content. Aluminum and iron sulphates are in general toxic to bacteria, protozoa and algae. Since but scant microscopic life can exist mosquito breeding is absent or very limited.

EFFECT OF WATER ON LARVAE

An effort was made to find out the effect of these waters on mosquito breeding. A large number of *Culex pipiens* larvae of different ages, bred in a receptacle placed outside to catch rain water, were placed in bottles containing samples of the waters collected. Chemical analysis of the rain water was made and the acidity determined. The samples were during the first 10 hours examined every hour and thereafter twice daily. Examination of the data secured indicates at once that acidity as such was not a limiting factor for breeding. The rain water had an initial P_H of 4.5 and after 8 days 11 of the 15 larvae had pupated and hatched, and but two larvae had died. Some of the samples were able to support the larvae for several days, others for 8 days or more. In the cases where 50 per cent. or over of the larvae died after 3 days, microscopic examination revealed the fact that the samples were nearly or entirely bare of life. The death of the larvae could in several instances be traced directly to the exhaustion of the food supply. In the cases where an insufficient food supply was present the larvae remained small and stunted. No effort was made to introduce food. In newly outlined experiments I will endeavor to feed the larvae without changing the chemical constitution of the samples.

Culex pipiens larvae persisted and in some instances hatched in slightly alkaline waters with a fairly high chlorine content, but when placed in water samples collected in the salt marshes the majority were dead after 6 hours and all were dead after 24 hours. The cause of death in all probability was due to the high chlorine content. Larvae of *Aëdes sollicitans* lived and in some instances hatched in slightly acid water, but placed in natural acid water (P_H 4.5) behaved similarly to culex larvae in salt water. Culex larvae placed in water from the clay pits survived and hatched in spite of acidity (P_H 4.6) and small amounts of aluminum but were killed with increasing rapidity with increasing amounts of aluminum and iron sulphates.

SUMMARY

Water samples from three distinct regions (cedar swamp and acid clay pits) were studied for chemical constituents, acidity and alkalinity, and for kind and abundance of microscopic plant and animal life. Breeding occurred in the cedarswamp waters whenever the acid water was stagnant. Acidity as such does not seem to affect mosquito breed-

ing. The chemical composition of these waters does not prevent breeding of certain species, but might determine kind of breeding. Food supply for larvae, which might be dependent on the chemical composition of the water, seems to be the main cause for breeding. High amounts of toxic aluminum and iron sulphates of the waters from clay pits prevent mosquito breeding. *Culex pipiens larvae* of all ages lived, pupated and hatched in all waters until the food supply was exhausted, except when relatively large amounts of Al and Fe sulphates were present.

STUDIES ON MICROSPORIDIA PARASITIC IN MOSQUITOES

VI. ON THE DEVELOPMENT OF THELOHANIA OPACITA, A CULICINE PARASITE *

R. Kudo

In a former paper (Kudo, 1922) I gave a brief description of a microsporidian, *Thelohania opacita,* which was found parasitic in the larvae of *Culex testaceus* (*C. apicalis*) of New York. In 1922 the protozoan was observed in a number of *Culex territans* from the same locality. A larva of the same species sent to me by Dr. M. A. Barber, U. S. Public Health Service, in January, 1922, from Brewton, Ala., proved to be parasitized by the same microsporidian. In the course of a survey of the microsporidian infection in anopheline mosquitoes in Lee County, Georgia, in 1923, I come across a larva of *Culex* sp. which was suffering from an infection with this protozoan (Kudo, 1924a). The present paper deals with the development of the microsporidian as observed in these infected host larvae. The following material was used: 1. Three larvae of *Culex testaceus* from New York, August, 1920. 2. A larva of *Culex territans* from Brewton, Ala., January, 1922. I am under obligation to Dr. Barber who kindly placed the material at my disposal. 3. Nine larvae of *Culex territans* from New York, September, 1922. 4. One Culex larva from Georgia, September, 1923.

The methods of fixation and staining and of studying the polar filament were the same as those used in the previous studies. All the developmental stages occurred only in the host's fat body cells. Very frequently the body cavity was filled with isolated spores as well as with stages in sporogony, which is without doubt due to the rupture of the membrane of the infected host cell.

The youngest schizonts are uninucleate rounded or oval bodies and measure 2.5 to 3.5μ in largest dimension. At first the nucleus is compact, although the chromatic substance is accumulated in its periphery, showing a ring form. The schizont grows at the expense of the cytoplasm of the host cell and its nucleus becomes vesicular. The nuclear character is quite similar to that of the corresponding stage of *Thelohania legeri.* The schizogony is a binary fission (Figs. 1-3).

* Contributions from the Zoological Laboratory of the University of Illinois, No. 248.

The daughter schizonts repeat the division as long as there is a large space left in the host cell, as was noted in other species, such as *T. legeri* (Kudo, 1924).

Some of the binucleated schizonts undergo nuclear divisions without being accompanied by cytoplasmic constrictions and increase in size. The nuclear division takes place simultaneously. As a result, elongated bodies with from four to twelve nuclei are produced (Figs. 4-6), in which the daughter nuclei are arranged in pairs. These forms divide into smaller ones, each of which contains two nuclei (Fig. 7). The peculiar nuclear division observed in *T. legeri* does not seem to occur in the present species. This binucleated body appears to be the last product of the schizogony. Its nuclei are characterized by a more or less distinct membrane, a small centrally located chromatin grain and a conspicuous chromatin mass located at one end. The latter frequently becomes thrown out completely into the surrounding cytoplasm as small rounded bodies (Fig. 8), or may become distributed as a peripheral chromatin layer over the nuclear membrane. In the meantime, the two nuclei become closely associated with each other (Figs. 9, 10) and finally fuse into one. This is the sporont and is the starting point in the sporogony.

The nucleus of the sporont divides into two without returning to the resting stage (Figs. 12-16). The division is promitotic. The chromatin material forms a spireme (Fig. 12); achromatic fibers become conspicuous at first in a sort of network and later become stretched between the two poles of the division. During this division the greater part of the chromatin material remains attached to the nuclear membrane. In the interior of the nucleus 5 to 7 chromatin grains are seen collected in two places (Fig. 13). These seem to move to opposite poles (Fig. 14) and the spindle fibers become visible between them. The peripheral chromatin mass is divided into two groups and the two nuclei are thus formed (Fig. 16). In the second nuclear division two chromatin granules appear at each pole (Fig. 17). When this division is completed, a tetranucleated body is produced. The form shown in Figure 18 is probably a tetrasporous sporont in which no more nuclear division is going to take place, since the four nuclei are apparently in the resting stage. This kind of the sporont occurs in small number compared with the octosporous pansporoblasts. Each of the four nuclei of the tetranucleated sporont divides once more under ordinary conditions (Fig. 19) in which one sees always two chromatin granules at each pole, two connecting chromatin threads being noticeable between them. When the divisions are completed there is produced a rounded sporont with eight nuclei (Fig. 20), around each of which the cytoplasm becomes

condensed and thus forms eight sporoblasts (Fig. 21). Each sporoblast develops into a spore (Fig. 22). The changes described here are similar to those of the corresponding stages in *T. legeri;* but the extra-nuclear chromatin granules which appear in abundance during the sporogony in the latter species are less conspicuous in the present form.

The spores are broadly ellipsoid (Figs. 23-29) and circular in end view. In some spores the two extremities are dissimilar in form; one end where a distinct round, oval or triangular clear space is visible, is more rounded than the other. Still in some other spores, the ends are somewhat equally or unequally truncated. The contents of the spore are finely granulated, as is usually the case, although in abnormally large spores one finds indications of the coiled polar filament (Fig. 29) which was noted in the spores of *Stempellia magna* (Kudo, 1924b).

Textfig. The infected larval *Culex territans* from Alabama. Preserved, × 15.

The spores show a dimorphism, owing to the octosporous and tetrasporous spore-formation. The former occurs more commonly and gives rise to smaller spores (the so-called microspores), while the latter takes place less frequently and gives rise to larger spores (the so-called macrospores). As far as can be seen, the two types of the spore differ from each other only in dimensions, and not in the structure. The normal spores measure in fresh conditions 5.5 to 6μ long by 3.5 to 4μ broad, while the fresh large spores are 8 to 8.5μ long by 4.5 to 5.5μ broad or even reach 10μ long by 5.7μ broad.

When the spores of either type are subjected to mechanical pressure the polar filament becomes extruded from the side or the tip. This is unusual, since in all the species of Microspoidia which I have studied up to the present, the filament has always been extruded from one of the ends of the spore. In moderately pressed spores of the present species,

longitudinal lines were often very distinctly seen on empty spore membrane (Fig. 33). I consider from this evidence that the spore membrane of the present species is composed of two valves in a way similar to a myxosporidian spore membrane. In the literature, one finds but a few records concerning this peculiarity. Thélohan (1895) observed the sutural line of the shell-valves of the spores of *Glugea anomala* and *Thelohania giardi.* Lutz and Splendore (1904) figured a spore of *Plistophora simulii* in which two shell-valves split after the extrusion of the polar filament. Mercier (1908) noticed the sutural line of the spore membrane of *Plistophora* sp. Thus the present species furnishes another evidence to show the close structural relationship between myxosporidian and microsporidian spores. The extruded polar filament of the normal spore is 90 to 110μ long, while that of the larger spores reaches 200μ in length.

Of the conditions of the three larvae of *Culex testaceus* I made brief mention before (Kudo, 1922). The larval *Culex territans* from Alabama was heavily infected throughout the entire body; particularly the thoracic segments were so greatly distended as to present a highly peculiar appearance (Fig. 34). The opacity and inactivity of the host must have been quite conspicuous when it was caught.

Nine larvae of *C. territans* from New York showed the following symptoms: 1. Body deformed, right side of the anterior abdominal segments greatly distended; activity subnormal. 2. Body moderately opaque; all the tracheal gills showed octosporous sporonts and free spores; size normal; inactive. 3. Thorax opaque white; one of the tracheal gills showed the spores; mild infection. 4. Thorax opaque orange and abdomen opaque white; tracheal gills showed non-sporulating and sporulating sporonts and isolated spores; spores are also found in the respiratory tube; inactive. 5. External appearance and behavior normal; infection detected by microscopical examinations. 6. Body extremely opaque white and slender; lived seven days in captivity. 7. First three abdominal segments opaque white; tracheal gills showed a few spores. 8. Third thoracic and second to fifth abdominal segments showed opaque whitish coloration; very inactive. 9. The entire body opaque white; very sluggish; tracheal gills showed sporulating sporonts and isolated spores.

The Culex larva from Georgia showed extreme opacity of the entire body which was somewhat distended irregularly; movements were very sluggish. When it was brought into the laboratory with the anopheline larvae, it was lying on the bottom of the jar without any visible movements.

In all the host larvae so far encountered, the infection was seen to have advanced to such an extent that the greater part of the fat body was practically completely filled with the various stages of the microsporidian so that there is little doubt as to the untimely death of the hosts due to the infection. Adult mosquitoes were not studied in large numbers as to lead me to make any definite statement. In all, thirty-five adults bred in the laboratory were examined in 1922 in smears, but none showed any indications of the microsporidian infection. Viewed from the findings I made in Georgia (Kudo, 1924a), it is quite possible, however, to assume that when the infection in the larva is slight or moderate, the host would be able to metamorphose into an adult mosquito.

SUMMARY

1. The development of *Thelohania opacita,* parasitic in *Culex testaceus, C. territans* and *C.* sp. is given.

2. The schizont multiplies by a binary fission. At the end of schizogony, binucleated forms are formed. After the fusion of the nuclei, the sporont is produced.

3. Both octosporous and tetrasporous sporonts occur, which develop into normal and smaller spores and larger and abnormal spores, respectively. The small and large spores are similar in structure.

4. The spore membrane is composed of two valves.

5. The microsporidian infection is fatal to the hosts in the cases observed.

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PLATE XVII

Explanation of Plate XVII

Figs. 1-7.—Stages in schizogony. 1-3, stages in binary fission. 4-6, multinucleated schizonts. 7, ultimate product of schizogony. × 2300.

Figs. 8-22.—Stages in sporogony. 8-11, stages in formation of the sporont. 12-16, stages in the first nuclear division of the sporont. 17-18, stages in the second nuclear division. 19-21, stages in the third nuclear division, forming eight sporoblasts. 22, a pansporoblast containing young spores. × 2300.

Figs. 23-33.—Spores fully formed. All seen in fresh condition except Figures 32, 33. 23-25, 27-29, normal and large spores. 26, an end view of a spore. 30, an octosporous pansporoblast. 31, a tetrasporous pansporoblast. 32, a stained spore. 33, an empty spore membrane, showing the shell-valves. 23-31, × 2360; 32, × 2300; 33, × 3200.

NOTE ON *ANCYLOSTOMA BRAZILIENSE* AS A HUMAN PARASITE IN THE PHILIPPINES

C. Manalang
Philippine Health Service

Darling, in 1923 (J. Parasit., 9:234), reported the presence of *Ancylostoma braziliense* in the Philippines on the basis of some specimens taken from a dog at Manila. In connection with hospital and institutional work by the present writer, the same parasite has been frequently encountered as a human parasite, always in association with *Ancylostoma duodenale* or *Necator americanus,* sometimes all three species being present. Those observed were always in Filipinos; none so far have been found in Chinese, Japanese or Americans. They have

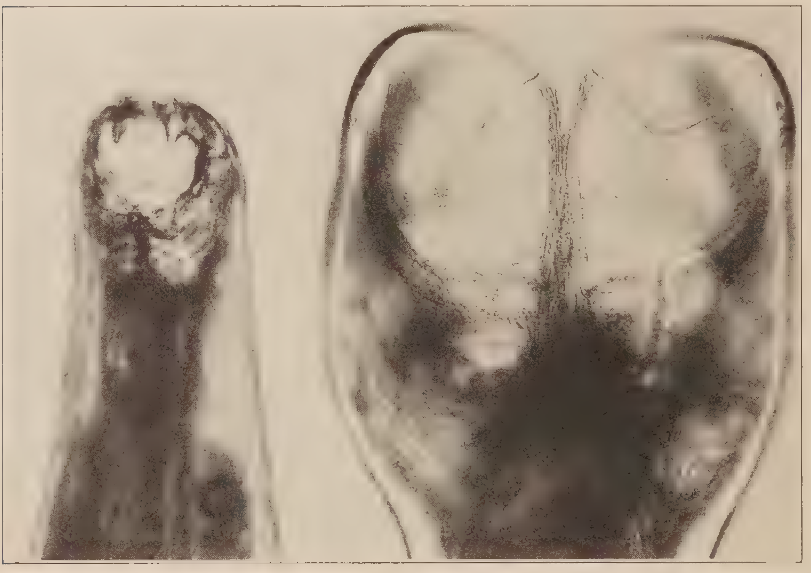


Fig. 1.—Buccal capsule of a female (left), Bursa of male (right). Microphotographs by Major Callender, M. C., U. S. Army.

been found in over 11 per cent. of 136 hospital cases treated for hookworm infection from three provinces of Mindanao and Sulu and one province of the Visayan group. They constituted about 1 per cent. of a total of 1,000 parasites found in 115 inmates of a penal farm whose population is rather representative of the Archiplego. In the view of the small numbers present in any one case (four having been the maximum recovered from a single patient) and the dominance of the other two species, it is believed that the human infestation is probably accidental, and that the usual hosts are probably cats and dogs, from which animals most of the specimens heretofore reported in the literature have been collected.

SOCIETY PROCEEDINGS

THE HELMINTHOLOGICAL SOCIETY OF WASHINGTON

The seventieth meeting was held Oct. 27, 1923. The Secretary introduced Professor F. Fülleborn, of Hamburg, Germany, as guest of the evening. On nomination, Professor Fülleborn was elected Foreign Corresponding Member, vice Arthur Looss, deceased.

Dr. E. C. Faust gave an account of recent experiences in China. He made a preliminary report on the life history investigation of *Clonorchis sinensis* which he is carrying on in cooperation with Dr. C. H. Barlow in Chekiang Province, China. The molluscan host in this area is found to be *Melania hongkongensis,* identified by Dr. Nelson Annandale, while the piscian hosts consist not only of Cyprinidae but also of bass and bottom feeders. The Clonorchid cysts frequently occur on the under sides of the scales of some of these fishes. In this area the disease is rare in man, but cats carry a 100 per cent. infection and dogs are heavily infected.

In discussion, Stiles stated that the U. S. District Court in Boston had recently upheld the government in the clonorchiasis habeas corpus proceedings. The significance of the decision lies not only in the question of clonorchiasis, from the viewpoint of inspection of immigrants, but in the broader public health contention by the government which in regulations makes the term "communicable" disease synonymous with "contagious" disease (used in the law). The contention is to the effect that a "contagious" disease is one contracted by coming in contact with a "contagium" (i. e., infectious material) rather than with the patient who harbors this "contagium;" it is the "contagium" itself, not the patient, that is dangerous; accordingly, any disease which is "communicable" by means of a "contagium" is a "contagious" disease, or synonymously a "communicable" disease. Had the government lost this case, re clonorchiasis, the procedure and regulations on the medical inspection of immigrants would have been seriously handicapped.

Miss E. B. Cram presented the following notes:

New Records of Horse Strongyles: *Cylicostomum leptostomum.*—Previously reported from Hungary and Holland. Has been found twice in collection of Zool. Div.: *(a)* Among specimens collected by Ransom and Hadwen from the first colon of a horse at Vonda, Saskatchewan, on Oct. 4, 1918; (*b*) Among specimens collected by J. W. Kalkus, Pullman, Wash., and sent in for determination, April, 1923.

Cylicostomum ultrajectinum.—Previously reported from Hungary and Holland. Has been found twice in collection of Zool. Div.: (*a*) Among specimens collected by Ransom and Hadwen from the fourth colon of a horse at Vonda, Saskatchewan, Oct. 4, 1918; (*b*) among specimens collected at Bethesda, Md., July 26, 1920.

Cylicostomum ornatum.—Previously reported from Hungary. Has been found among specimens sent to Zool. Div. for determination from J. W. Kalkus, Pullman, Wash.

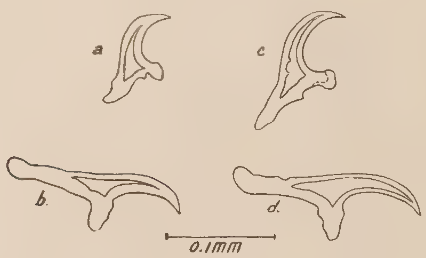
A Specimen of *Belascaris marginata* with Three Uteri and Ovaries.—Among specimens of *Belascaris marginata* which were being dissected in order to obtain the eggs for culturing, one specimen was found to have three uteri and ovaries, instead of the normal number of two. One uterus was slightly larger than the others and branched off from the vagina at a somewhat higher point. In other respects the three were very similar, and all were filled with eggs. This is apparently the first abnormality of its kind to be observed in this species. Several similar records concern other species: in *A. lumbricoides* three uteri and ovaries have been noted by Balss and more recently by Chandler; in the same species a single uterus and ovary by Schewiakoff and by Harms.

A specimen of *Ascaris megalocephala* with an unpaired genital apparatus was reported by Harms. Schewiakoff found a double rhachis in the ovary but Harms did not find this in either of his specimens, so that there was no indication that two ovaries had fused.

Cysticercus (?) tarandi from the Musculature of a Deer.—There were sent to the Zoological Division in October by B. T. Simms of the Experiment Station at Corvallis, Ore., pieces of muscle from a deer shot in Cow Creek Canyon, Oregon. In the musculature were five small cysticerci. The shape and sizes of the hooks (Text-figure A), the gross appearance of the bladders and the microscopical appearance of their walls agree fairly well with those of *C. tarandi*, which is the larval stage of *Taenia krabbei* of the dog. This cysticercus has formerly been reported only from the reindeer of Eurasia and Alaska. The identification can only be made tentatively from these specimens but it will be of scientific and possibly economic interest to watch for additional cysticerci from the deer and for the adult tapeworm in wild carnivores of that region.

The following note was presented by C. W. Stiles and Gertrude Brown:

Nomenclature of the Nematode Genera Belascaris 1907, Toxascaris 1907, and Toxocara 1905.—The nomenclature of the arrow-headed ascarids has become slightly confused, but in reality the case is not a difficult one. The arrow heads



a-b *Cysticercus tarandi.*
c-d Cysticercus from deer.

Text figure A.

were first separated from Ascaris and allocated to a special genus (Toxocara, type *Lumbricus canis* Werner, 1782) by Stiles (1905). Leiper (1907) divided the arrow-headed ascarids into two new genera *Belascaris* (type *mystax*, 1800 of cat = *cati*, 1788) and *Toxascaris* (type *leonina* 1902), but apparently Toxocara escaped his attention. Railliet and Henry (1911) adopted Leiper's two genera and concluded that Toxocara should be eliminated from consideration on the ground that the type species *L. canis* 1782 is unrecognizable, and most authors have followed this interpretation.

To adopt the principles enunciated or implied by our French colleagues in this case involves admitting procedures which would threaten many of the genera and species in Zoology published prior to the modern taxonomic points of view, for relatively few of them were originally described with details now considered desirable. Accordingly, in dealing with old species it is necessary to follow the history of the literature to determine how they were divided and more closely defined. Compare, for instance: *Taenia solium* L., 1758a; *Amoeba coli* Loesch, 1875a; etc.

From Werner (1782) it is beyond dispute that *Lumbricus canis* was an arrow-headed ascarid—in fact, the earliest or one of the earliest ones known. Gmelin (1790a) placed it in Ascaris. Rudolphi (1793a; 1802a) recognized *L. canis*, from his taxonomic viewpoint, and (1802a) renamed it *A. marginata* with a division of the species and a rejection of the oldest name; accordingly, *marginata* 1802 is an objective synonym of *canis* 1782. Zeder (1800a) distinguished it specifically (as *Fusaria werneri)* from *Fusaria mystax.*

Leiper (1907) placed *A. marginata* 1802 (i. e. *canis* 1782 renamed) in *Toxascaris*, thus inadvertently jeopardizing his genus *Toxascaris* 1907, which is antedated by *Toxocara* 1905. Railliet and Henry (1911) rightly showed that Schneider (1866a) had restudied Rudolphi's specimens of *A. marginata* (i. e., *canis* renamed) and on basis of the data presented by this restudy they claimed that *A. marginata* (i. e., *canis* renamed) is a Belascaris and transferred it to this genus.

Thus, according to the deductions by Railliet and Henry (1911) it is necessary to conclude that Belascaris contains the type of *Toxocara* (i. e., *canis*, renamed *marginata*, characters established by Schneider). Admitting the correctness of the view advanced by Railliet and Henry, *Belascaris marginata* (objective synonym *Lumbricus canis*) and *B. mystax* are congeneric. Thus, on basis of Railliet and Henry, Belascaris 1907 becomes a synonym of Toxocara 1905.

As the foregoing point seems to have escaped attention of authors, it seems advisable to present it now, and to invite attention to the fact that the renaming of a systematic unit establishes an *objective synonym* which is on quite a different basis from a *subjective synonym*. Had Rudolphi described *marginata* as distinct, and later given *canis* as a subjective synonym, the point of view advanced by Railliet and Henry would have a slightly different basis, but as *marginata* 1802 is an objective synonym of *canis* 1782, Rudolphi's specimens, reexamined by Schneider (1866) (results accepted by Railliet and Henry 1911) invalidate the latter's conclusion to reject Toxocara.

Dr. B. Schwartz presented the following notes:

Occurrence of *Fasciolopsis buski* in the Philippine Islands.—In April, 1923, I found the eggs of *Fasciolopsis buski* in the stools of several Chinese in the town of Jolo, Sulu Archipelago, P. I. This parasite is now recorded for the first time from the Philippines. Despite the numerous helminthological surveys that have been made from time to time in these Islands, principally in the Island of Luzon, *Fasciolopsis buski* has not been previously found there, although numerous Chinese prisoners in Bilibid prison were included in these surveys. This parasite is apparently limited to the Sulu Archipelago.

Carbon Tetrachlorid as a Tapeworm Remedy.—In the course of a hookworm campaign that is being conducted by the Philippine Health Service, tapeworms *(Taenia saginata)* were found from time to time in the bowel discharges of patients treated with carbon tetrachlorid (dosage about 8 to 12 c.c. for adults). *T. saginata* is by no means a common parasite of man in the Philippines, and its appearance from time to time in the stools of treated persons would indicate that carbon tetrachlorid has a high degree of efficacy as a remedy for this parasite.

Occurrence of *Ancylostoma braziliense* in Philippine Cats.—All cat hookworms from the Philippines that I examined were found to be *Ancylostoma braziliense*. This species has been recently reported from Philippine dogs by Darling. Its occurrence in man is highly probable. So far I have not found it among my hookworm material from man in the Philippines.

Absence of Bots (Gastrophilus) in Philippine Horses.—Larvae of Gastrophilus were not found in the stomach of Philippine horses and these negative findings were confirmed by veterinarians who have had considerable experience in the Philippine Islands. According to entomologists in the Philippine Islands, the adult flies have not been reported from that country.

Comparative Scarcity of Trichuris in Philippine Dogs.—Only 2 dogs out of a total of about 60 autopsied in Los Baños were found to harbor Trichuris. Wharton posted over one hundred dogs in Manila but found no Trichuris in these animals. Species of Trichuris are of common occurrence in man and in various domesticated animals in the Philippine Islands.

In discussion Faust stated that carbon tetrachlorid has proved to be of value against Fasciolopsis. Ransom recalled that Hypoderma had not become established in the Southern hemisphere; there are three species of Gastrophilus in the United States and the progressive distribution can be traced by the extent to which nose guards are used on the horses.

Dr. M. C. Hall presented a note on the effect of the bite of the wheel-bug *(Arilus cristatus)* on a child 10 years old. The bug inflicted two bites on the little finger of the right hand on the inner surface near the nail. The finger became hot and reddened and a cutaneous growth resembling a papilloma developed at the site of each bite. The finger remained warmer than the other fingers for months and the growths persisted for months, the last one slowly disappearing from the sixth to the ninth month after the injury. A year later the child claims that the injured finger still feels warmer at times than the other fingers on the same hand. The lesions suggest the action of a toxic irritant acting as a stimulant to tissue growth.

Captain Butler, U. S. N., presented the following note:

Dr. E. B. Saye, pathologist of the Georgia State Sanitarium, Milledgeville, Ga., wrote to Admiral Stitt for information in regard to *Linguatula* in the nostrils of a number of dogs from the surrounding territory. Some of these dogs showed symptoms simulating rabies but Negri bodies were not found in the brains of these animals. Sometimes dogs infested with this parasite show symptoms of this nature and the point was made that people bitten by such animals would not require the Pasteur treatment, which is rather tedious and disagreeable.

Hall recalled that pseudorabies had been associated also with *Dioctophyme renale, Ancylostoma caninum,* and Echinococcus. Ransom stated that *Linguatula rhinaria* had been found in this country in the liver of *Bos taurus* but that it had rarely been found in dogs. Dr. Stiles recalled that about 1895 several cases of intestinal pseudotuberculosis in *Bos taurus* had been sent in from Pennsylvania and that they had proved to be due to larval *L. rhinaria.*

Dr. B. H. Ransom reported that the Netherlands had notified this government that pork will be accepted there if refrigerated for not less than 3 weeks at not higher than—15° C., as a prophylactic measure against trichinosis.

Dr. C. W. Stiles presented the following:

Possible Solutions of the Present Concurrent use of Generic Names sensu lato and sensu stricto, example Ascaris.—Both parasitologists and bacteriologists are constantly finding and recording species which from the standpoint of Rudolphi (1819) or Diesing (1850) would be classified in a given genus, say Ascaris sensu lato, but which today no helminthologist would think of classifying in Ascaris sensu stricto, type *lumbricoides.* As a result, many of our generic names have a double meaning and are, systematically, very confusing. Part of the problem has been solved by Diesing, who proposed the following names as collective groups for nematodes of uncertain position: Agamonema Dies., 1851a; Agamonematodum Dies., 1861a; Agamonematoideum Dies., 1853a; Nematodum Dies., 1861a; Nematoideum Dies., 1851. Later Stossisch, 1892, proposed Agamodistomum for agamic distomes; Brandes, 1892 proposed Amphistomulum for agamic amphistomes and Distomulum for agamic distomes; Stiles proposed Agamomermis, 1903, for agamic Mermithidae, and Agamofilaria, 1907, for agamic Filariidae; Henry and Sisoff, (1913) have used Agamospirura for agamic Spiruridae. Cercaria, Cysticercus, Microfilaria, and several other names are usually recognized as of the same general status, namely, as purely collective groups for *larval* forms.

While Diesing's Agamonema 1851 will take care of agamic nematodes in general, and while Agamofilaria, Microfilaria, and Agamomermis, form a convenient temporary resting place for immature, but generically non-determinate, Filarioidea and Mermithoidea respectively, there are numerous cases which can be classified more closely than Agamonema but which are not provided for. Steiner mentioned agamic ascarids, for instance. Filocapsularia 1824 comes up for consideration to meet his case, but it seems unwise to adopt this name for these forms, because Filocapsularia was a distinctly monotypic genus, hence it may some day become valid. To take care of at least some of the cases unprovided for, it is possible to suggest, and on both theoretical and practical grounds to recommend, the use of the following names for agamic forms of

the supergeneric groups in question, in order to relieve the more natural typical genus of each group from its confusing status as a collective genus—Agamo-ascaris for agamic Ascaroidea; Agamo-oxyuris for agamic Oxyuroidea; Agamo-strongylus for agamic Strongyloidea; Agamo-camallanus for agamic Camallanidae.

These names will take care of most of the agamic parasitic nematodes which at present tend to produce confusion, but there are many other cases, more or less adult forms, which are not provided for. Take the genus Ascaris for instance. Properly speaking, from the present day viewpoint, the generic name Ascaris should be confined to Ascaris, sensu stricto, type *lumbricoides;* for instance, for the specimens reported as *A. lumbricoides, megalocephala, equorum, suum, suis, ovis, bovis,* etc. As a matter of fact, however, while Ascaris 1758 has been divided into a number of genera (Toxocara, Toxascaris, Belascaris, Contracaecum, etc), species continue to be described and reported as Ascaris s. l., thereby producing confusion with Ascaris s. str. In the interest of clearness of the classification, it would appear reasonable to allocate all species of Ascaris s. l. to their proper restricted genera as rapidly as feasible, and not to use Ascaris any longer as a collective genus. Even then there remain species of Ascaris s. l. of uncertain generic position. As a method worth considering, in order to meet the present confusion, I would suggest that an objective synonym of a valid genus might well be used as the collective generic name in these cases. For instance, Fusaria, 1800, is an objective synonym of Ascaris, 1758, and under the International Rules it can not possibly ever be used as a valid generic name. It might, however, be made our servant to serve a temporary practical service. It immediately suggests Ascaroidea to every helminthologist, but it does not suggest Ascaris s. str. If, now, Fusaria, instead of Ascaris, be accepted as the collective genus for Ascaroidea s. l., the generic name Ascaris will more rapidly gain a definite status such as obtains at present for Fasciola. Care would have to be taken in selecting as the name for the collective genus one which is not in use in some other group. Thus the following names might be used:

Fusaria Zed., 1800a, as a collective genus in place of Ascaris s. lato, thus avoiding confusion for Ascaris, s. str.

Spiroptera Rud., 1819a, as collective genus for Acuariidae, thus relieving confusion for Acuaria s. str., etc.

Trichosoma Rud., 1819a, as collective genus for Capillariinae, thus relieving confusion for Capillaria s. str., etc.

Sclerostoma Rud., 1809a, as collective genus for Strongyloidea, thus relieving confusion for Strongylus, s. str., etc.

Amphistoma Rud., 1801, as collective genus for Amphistomata, thus relieving confusion for Strigea, Paramphistomum, etc.

Distoma Retzius, 1782, as collective genus for Distomata, thus relieving confusion for Fasciola, etc.

Monostoma Rud., 1809a, as collective genus for Monostomata.

Dibothrium Dies., 1850a, as collective genus for the two-suckered tape worms, thus relieving confusion for Bothriocephalus.

Alyselminthus Zed., 1800, as collective genus for the four-suckered tape worms, thus relieving Taenia, s. str., etc.

The suggestion is that when an author describes an ascarid (Ascaroidea, Ascaris s. l.), which, for objective or subjective reasons, he is not in a position to allocate to its genus s. str. in the modern conception, namely, as based on a genotype, he would do well to classify it in the collective genus Fusaria (now not in use except as a synonym of Ascaris s. l.), rather than to use the name Ascaris which should be restricted, as rapidly as feasible, to Ascaris s. str., type *lumbricoides.*

The names cited above will, I believe, reduce confusion. All of the names except Sclerostoma would continue in identically their original sense; Sclerostoma, if used, would continue in a sense slightly broader than originally (1809);

still as it is a dead synonym of Strongylus, and as it has served more or less as a collective genus since 1809, the slight theoretical difference will be equalized by the reduction of confusion to which Strongylus is now subjected.

A slightly different plan is used by some authors, who, instead of citing a collective genus, place the family or subfamily name in parentheses and follow this by the specific name of the generically doubtful species. Thus, Handlirsch (1906) uses *"(Spiloblattinidae) balteata,"* and other similar citations.

Both of these methods have their advantages, but it is obvious that an author using the first of the two methods would do well to state definitely that he is using the name in the broad sense, s. l., namely, as a collective genus.

In conclusion, this occasion is utilized to emphasize again a point mentioned frequently, namely, it is much easier to kill an unnecessary name or to let it die than it is to unravel a composite biology which has become confused because an author unites the biology of two distinct species or genera under one name. Most zoologists argue against the creation of speculative new genera and new species, but there are two sides to this question. In order to safeguard biological data it seems much safer to run the risk of unnecessarily recognizing new species; accordingly, with full knowledge of the heresy involved, the point is maintained that it is in the interest of conservatism to follow the principle: In case of reasonable doubt, give a new name or at least do not classify an organism under an old name when a reasonable doubt exists as to the correctness of such classification.

Dr. N. A. Cobb reported the importation of *Tylenchus dipsaci* on seeds from South Africa. He also reported finding amphids on the triplonchs. He mentioned the practical application of corrosive sublimate with glycerin jelly in locating apertures of the body of nematodes, as the mercury crystals precipitate in the apertures. Dr. Cobb also discussed and demonstrated birefringents, which prove to be widespread both in animals and in plants. In free living nematodes the birefringents are so characteristic that they can sometimes be used for specific determinations. He demonstrated a new apparatus used to collect nematodes from soil, by means of a jet spray with a force sufficient to separate the nematodes from the other material.

Dr. C. W. Stiles and Gertrude Brown presented the following notes:

The Type Species of Monodontus Molin, 1861a.—In a recent paper, T. W. M. Cameron (1923) discusses the nomenclature of Monodontus 1861 vs. Bunostomum Rail., 1905, and presents conclusions which are not entirely in harmony with those of Railliet, Hassall, Stiles and others. In order to forestall possible confusion, we revert to the subject this evening.

The first point involves the question as to who first designated the type of Monodontus 1861, a point of practical bearing if Monodontus supplants Bunostomum. According to the International Rules (Article 30, g), "The meaning of the expression 'select the type' is to be rigidly construed. Mention of a species as an illustration or example of a genus does not constitute a selection of a type."

According to Railliet (1893a) "Molin (1861a) en [*Uncinaria cernua* s. *Monodontus wedlii*] avait fait, non sans quelque raison, le type d'un genre à part (Monodontus)."

According to Cameron (1923), "No type, however, was mentioned" by Molin, but "there is no doubt that Railliet had designated *wedlii*, now known as *trigonocephalus*, as type of the genus Monodontus before Stiles and Hassall, and accordingly it must stand." From these quotations it appears that Cameron differs with Railliet as to the point that Molin designated *wedlii* s. *cernua* as type. We have re-read Molin, as respects this point, and while we find that there can be no question in regard to his stating that this species belongs ("appartengono") to a new genus, we are unable to find any passage which "rigidly construed" makes *wedlii* s. *cernua* type of Monodontus; accordingly, we agree with Cameron on this point.

As we read Railliet (1893a) he simply states that Molin made *wedlii* (so. *cernua)* type of a new genus. As Cameron definitely considers that Molin did not mention a type species, Railliet's statement becomes, not only from the viewpoint of Stiles and Hassall (1899) and ourselves (1923), but also, logically, from the viewpoint of Cameron (1923) an error in quotation or a lapsus of some other nature. Accordingly, our interpretation as respects Railliet (1893a) is not in harmony with that published by Cameron. From our viewpoint, the first "rigidly construed" type-determination for Monodontus 1861 was by Stiles and Hassall (1899a) as *semicircularis;* the reasons for selecting *semicircularis* are stated by Stiles and Hassall (1905b).

The question as to whether Monodontus 1861 falls as a homonym because of Monodonta Lamarck, 1799, is one of an entirely different nature. The principle involved is one with which zoologists have been wrestling for decades, and the outlook for agreement in the near future seems somewhat hopeless. Under the present International Rules, the point is left to the individual interpretation of workers. Admittedly, this is a poor compromise, but it is the best that could be done after years of experience and discussion. The fact remains that Railliet (1902) rejected Monodontus 1861 because of Monodonta 1790, and introduced *Bunostomum,* type *trigonocephalum,* and this has now come into general use. Agree or not, as one will, with the wisdom of Railliet's (1902) proposition, the fact remains that it is in the interest of nomenclature not to upset a generally adopted generic name unless this is imperative under the rules. In view of Article 36 (recommendation), it is not clear to us that it is necessary to reintroduce Monodontus 1861 and to upset Bunostomum 1902. Our suggestion would be that this "sleeping dog" be allowed to enjoy his slumbers undisturbed.

A note by W. A. Riley and C. H. Kernkamp was presented, entitled: Flukes of the Genus Collyriclum as Parasites of Turkeys and Chickens (since published, Jour. Amer. Vet. Med. Assn., 64, February, 1924).

Dr. C. W. Stiles presented a summary of unpublished observations made by A. D. Weakly, N. A. Harper, A. C. Robeson and himself prior to the World War, on *Endamoeba gingivalis* among the insane. In a study of fifty persons, there was a group of twenty-seven patients at the Government Hospital for the Insane who received six doses of emetin each, July 24 to 31; twenty-four of these twenty-seven patients showed amebae within a few days prior to the administration of emetin and the three other patients were pyorrhea cases.

Clinically, the following results were observed for twenty-five cases on Sept. 22, 1915, and for two cases on July 1, 1916: Improvement marked in three cases (11 per cent.), slight in 9 cases (33 per cent.), none in fifteen cases (56 per cent.). Of these twenty-six patients who received six doses of emetin, final microscopic record (after treatment) is available for twenty-six cases as follows: twelve persons (44 per cent.) showed amebae within four days after treatment; six (22 per cent.) patients additional showed amebae within ten days; four (15 per cent.) within thirty-one days; two (7 per cent.) within fifty-nine days; two (7 per cent.) remained negative for a total of thirty-two cover-glasses up to fifty-nine days, and nine months after treatment both were still negative; in one of these last patients, a typical pyorrhea case, no ameba had been found in four covers prior to treatment. The case of severe pyorrhea which showed no ameba in thirty-six smears, extending over a period of nine months, is unique in Dr. Stiles' personal observations on *Endamoeba gingivalis.*

Dr. C. W. Stiles and Miss A. J. Speer presented the following note:

Amoeba Bory, 1822, vs. *Amoeba* Huebner, 1826 (or ? 1816, or ? 1818).

The generic name Amoeba Bory, 1822, (originally Amiba Bory, 1822, emended to Amoeba by Ehrenberg, 1830) has become more or less sacred to zoologists, and when on several occasions available data threatened it protests arose. An apparently overlooked danger threatens this name now and it seems wise to present the facts in order to forestall confusion.

Dyar (1902, B. U. S. N. M., p. 288) quotes Amoeba Huebner, 1818, as a synonym of Petrophora Hübner. This Amoeba 1818 does not appear in Scudder's Nomenclature, hence it has been quite generally overlooked. A copy of Hübner, available to us, bears the date 1816, and on page 333 has "Amoebae" and "Amoebe," with diagnosis and seven species. If the evidence ended with this copy of Hübner, Amoeba Bory, 1822 (the Protozoon) would fall às a homonym of Amoeba 1816, since the date borne by a publication is assumed to be correct unless proved to be incorrect. We have intentionally remained silent on this point for some months in the hope that further evidence would develop.

An examination of the *Index animalium, 1923,* p. 270, of that indefatigable British scholar Sherborn, appears to alter the situation, for he gives 1826 as the date of publication of p. 333 of Hübner's Verzeichnis; see, also Hampson (1917, Entomol. News, p. 466). As it is to be assumed that Sherborn and Hampson have had the evidence before them, Amoeba Bory, 1822, appears to have priority over Amoeba Hübner, and is therefore not jeopardized by it.

This point is of practical importance in connection with a number of parasitic protozoa cited in literature and especially in connection with the free living protozoa.

The seventy-first meeting was held at the School of Public Health, Johns Hopkins University, Nov. 17, 1923.

Prof. Fülleborn, of Hamburg, gave a lantern-slide demonstration of *The Wandering of Certain Nematode Larvae in the Body of Their Hosts:* The penetration of the filariform larva of Strongyloides into the skin of its host appears to be a purely mechanical process, since upon evaporation of the fluid in which they happen to be, these larvae bore into Daphnia and all sorts of other objects. The thermotaxis of the filariform Strongyloides larvae considerably facilitates, in fact, the penetration into the skin of warm-blooded animals, but experiments conducted in Fülleborn's laboratory by Dr. Kosuge showed that these larvae can penetrate the cold skin of dead warm-blooded animals and also the skin of frogs; these experiments did not give data in support of chemotaxis (in sense of Brumpt) which would facilitate the finding of the proper host on the part of the larvae; on the other hand, larvae of certain free living nematodes were able to penetrate into human umbilical cord tissue. In the case of Heterodera larvae (which according to Baunacke were attracted for a distance of 2 meters by the roots of plants) and in the case of Mermis larvae (which according to Cobb and his colleagues sought out the grasshoppers that were torpid at night) xenotaxis might develop more readily than in the case of Strongyloides larvae which would not be able to follow the host animal as it walks over the infected ground. It seems to be a game of "trial and error," in sense of Jennings, that some of the Strongyloides larvae find the right host, in which they penetrate through the skin, and in which they can develop further, while this does not happen to the vast majority of the larvae. That larvae which do not enter the right host where they can develop to sexual maturity can also find, under some circumstances, a mode of infection, is shown by observations on *Rhabdias nigrovenosa* (s. *bufonis*), the larvae of which usually infect frogs through the skin, but which otherwise, for example, can live a long time in snails, and which we can transmit to frogs by feeding snails infected with the *Rhabdias* larvae; in the latter case the worms reach the lungs via the stomach wall and the liver of the frogs.

Further, also, we can infect dogs not only by feeding embryonated eggs of *Belascaris marginata* (= *Toxocara canis*), but also by feeding the larval stage, which after passing the pulmonary blood vessels can encyst (like Trichinella) in the terrain of the somatic circulation, (for example, in the muscles of mice and guinea-pigs); finally the larvae of Belascaris (cf. Toxocara) might even infect *per cutem,* as they occasionally hatch from the eggs outside their host and they can bore through the skin.

From that moment on, when Strongyloides larvae after percutaneous infection, have entered the circulation, up to their arrival in the intestine, their transport is purely mechanical; also the forward movement of the larvae which have bored from the lung capillaries into the bronchioli is purely mechanical and is caused by the ciliated epithelium of the air passages.

On the other hand, why is it that Ascaris larvae, however, apparently remain and grow in the bronchioli for a number of days, in spite of the ciliated epithelium? It would seem that for Ascaris as well as for Ancylostoma and for Strongyloides a sojourn in the lungs is a phylogenetic necessity, reverting back to the free life of their ancestors; in fact, Strongyloides can become sexually mature in the air passages of the dog, and seemingly also of man, similar to what obtains for *Rhabdias nigrovenosa* in frogs. Worthy of note is the fact that Shillinger and Cram found larvae of Belascaris (cf. Toxocara), grown to a length of about 1 mm. not only in the lungs of new-born puppies, as Fülleborn did, but also in their liver, when their mother had been used, during pregnancy, for experimental infection with Belascaris; on the other hand, the fact that *encysted* larvae were not found in the organs of the new-born puppies, but only of adult dogs, is perhaps an important suggestion in the problem of immunity.

The larvae of some Trichotrachelids, also, reach the lungs but do not develop there further; to them the passage through the lungs is only an indispensable part on their way to the organs of the somatic circulation; thus, Trichinella passes through the lungs on its way to the striated muscles; probably also the larvae of *Trichosomoides crassicauda* to the bladder of rats and the larvae of *Trichosoma cutaneum* to the skin of apes. The larvae of *Hepaticola hepatica,* also, do not require a passage through the lungs, but when they hatch out of the eggs in the gastro-intestinal tract of the rat they are carried by the circulation only to the liver; here they become sexually mature, although occasionally immature specimens are found which have "accidentally" reached the lungs and the brain. As a sojourn in the lungs is unnecessary—or has become unnecessary—for the trichotrachelid larvae, it is not to be wondered at that *Trichuris trichiura* and other species of Trichuris, according to Fülleborn's experiments, develop in the large intestine without further migrations. The retractile buccal stilet which Fülleborn has found in the youngest larvae of Trichinella, Trichuris, Hepaticola, and Trichosomoides, possibly indicates a relationship with one of the free-living nematodes which also have a buccal stilet. In reply to a question by Fülleborn, Cobb expressed the opinion that, from given anatomical data, perhaps the Dorylaimus group might come into consideration, while according to Wuelker the Allantonema group is descended from the Tylenchinae, and Strongyloides from the Rhabditinae. Fülleborn's investigations, now in progress, indicate that with *Oxyuris* (i. e., *Enterobius) vermicularis* there is no migration in the liver and lungs and that Enterobius can, perhaps, reproduce in the intestine of its host in the same way as proved for *Rhabditis hominis.*

During the discussion, Fülleborn, in reply to a question, stated that he knew definitely of one negro death due to Strongyloides; this latter point was of special clinical interest to the Americans who have thus far observed clinically important cases of Strongyloides only in the whites. Fülleborn also recalled one case of Strongyloides which had been somewhat improved by treatment with flowers of sulphur, but Shillinger reported that this did not prove of use when administered to rats.

Dr. W. H. Taliaferro presented the following:—Note on *Endamoeba barreti* Taliaferro and Holes, from *Chelydra serpentina:*

Dr. H. P. Barret and Miss N. M. Smith have succeeded in cultivating an Endamoeba from the snapping turtle, *Chelydra serpentina,* in a medium consisting of a 1 to 10 dilution of inactivated human blood serum in 0.5 per cent. saline. Cultures are kept in an ice box and transfers are made about once a week. The oldest culture was started on March 14, 1922, and is still running

after sixty-seven subcultures. Taliaferro and Holmes have been able to continue these cultures and have made a careful comparative study of the ameba from the turtle and from Barret and Smith's cultures. In the ameba from the turtle, the habitat, lack of a contractile vacuole, and the structure of the nucleus indicate that it is an Endamoeba (cogeneric with *E. coli*) for which Taliaferro and Holmes propose the name *E. barreti.* Furthermore, the amebae from the turtle and from Barret and Smith's cultures correspond in minutest detail and leave no doubt that Barret and Smith have cultivated this entozoic form.

Dr. B. H. Ransom presented a communication to the effect that Sparganum occurs in the United States in Wisconsin under the skin of the black fox. Also on the presence of Oesophagostoma larva on the peritoneum of sheep.

Dr. Benjamin Schwartz presented the following note on: *The helminthological fauna of man in the Philippine Islands.*

Trematoda: Five species of trematodes, namely, *Paragonimus westermanii, Clonorchis sinensis, Schistosoma japonicum, Fasciolopsis buski,* and *Echinostoma ilocanum,* have been recorded from the Philippines, the occurrence of these species being based on records of more than one individual, and three additional species, namely, *Fasciola hepatica, Fasciola gigantica,* and *Opisthorchis noverca* are reported by Musgrave, each on the basis of a single record. Musgrave states that the records of *Fasciola gigantica* and *F. hepatica* are merely probable since the material in question was not thoroughly identified. Only one of the species of trematodes recorded from man in the Philippines, namely, *Echinostoma ilocanum,* is peculiar to the Philippine Islands, the distribution of this parasite being limited to several provinces in northern Luzon. Clonorchis, Fasciolopsis, and Opisthorchis have not been recorded from native population.

Cestoda: Two species of cestodes, namely, *Taenia saginata* and *Hymenolepis nana,* are relatively common occurrences in the Philippines. Other cestodes that have been found in man in the Philippine Islands are: *Taenia solium, T. philippina, Hymenolepis diminuta, Davainea madagascariensis, Diphyllobothrium latum* and *Dipylidium caninum.* Infestation of man with cysts of Echinococcus and with *Cysticercus cellulosae* are also on record from the Philippines.

Nematoda: Nematodes are the most important parasites of man in the Philippines from the viewpoint of their frequency as well as from a clinical viewpoint. *Ascaris lumbricoides* is an extremely common and clinically very important parasite, a very large proportion of the native population being infested. *Ancylostoma duodenale* and *Necator americanus* are prevalent in the Philippines, the latter being by far the commoner species of hookworm. *Trichuris trichiura* is very abundant in certain localities and comparatively scarce in others. *Enterobius vermicularis* is fairly common and a related oxyurid, *Syphacia obvelata,* has been recorded once. *Strongyloides stercoralis* is not very common in the Philippines. *Filaria nocturna* has been recorded from several different localities in the Philippine Islands.

In the discussion, Capt. Butler brought out the importance of *Ascaris lumbricoides* in Guam children who show practically 100 per cent. infection. Dr. Stiles emphasized the changes of error of diagnosis in cases of children suffering from appendicitis, pneumonia, Ascaris, or hookworms, four conditions which during certain stages of the affections can be easily confused with one another; he mentioned an instance of four children in one family who were first diagnosed by an excellent clinician as cases of pneumonia, but which upon consultation proved to be heavy infection with Ascaris; the possible confusion of early pneumonia in children with appendicitis is common; hookworm infection and Ascaris infection can both be erroneously diagnosed both as pneumonia and as appendicitis, and conversely it is possible clinically to mistake both early pneumonia and appendicitis for hookworm or for Ascaris infection.

Miss Cram presented the following abstract of a paper: *Diphyllobothrium latum* in Minnesota, by William A. Riley, University of Minnesota.

The author in the past five years has known of fourteen cases of the occurrence of *D. latum* in man in Minnesota. Seven of these he has previously reported. In this paper he records a new case and reviews several which have been described by other authors. The new record is that of a Jewish woman, born in Russia, but for the past thirty-three years a resident of Wisconsin and Minnesota. The patient was extremely fond of fish, especially lake trout. The previously described cases which are here reviewed are all of native Americans; two cases reported by Nickerson and two by Riley from Minnesota, two by Calvin from Chicago, and one by Wallace and Green from Indiana. There was no question but that the infection had been locally acquired in these cases, and thus the evidence is clear cut that the parasite is endemic in certain sections of the United States. The number of cases from Minnesota alone now totals sixty-five. The author calls attention to the suggestion of various writers that the species may not be *D. latum,* but a closely related form found in native carnivores. Whatever the species, it is evident that the Diphyllobothrium is in Minnesota "by all odds the commonest of the large tapeworms of man."

Dr. G. Steiner exhibited drawings and made remarks about the food of the many species of Dorylaimus and related genera, living in soil and fresh water. Having a spear-like onchium, or a true spear, most of the species were thought to feed on plants and a number of them were seen with green intestinal contents which in a few cases were recognized as chlorophyll. However, not all Dorylaimi are plant feeders. In the intestine of a *Dorylaimus regius* de Man, one of the largest species of the genus, a seta of an Oligochaete was observed and in another specimen the intestinal content consisted of a mass containing so many nuclei that their origin could hardly have been anything but a gonad of an animal. Dr. Steiner's paper was discussed by Cobb and Ransom.

Dr. Maurice Hall presented the following note and exhibited the specimen involved: *A Grasshopper Attaching in the Mouth of the Cat.*—A specimen was recently sent in to the Bureau of Animal Industry by Professor R. F. Bourne of the Division of Veterinary Medicine of the Colorado Agricultural College with the following history: The specimen was collected by a veterinarian near Leesburg, Fla., and turned over to Dr. Frank C. Wilson of Leesburg with the statement that the veterinarian had been called in to see a cat that had been losing flesh and appetite for several days, and had found this supposed parasite firmly attached to the upper side of the tongue and had removed it by means of pliers. The owner of the cat stated that another cat had died from apparent starvation and thought that some parasite was the cause of the trouble. The specimen found in the Leesburg case was forwarded to Professor Bourne and by him to us.

In sending the specimen Professor Bourne noted that it had some resemblance to crustacean, and as it did have such a resemblance on superficial examination and did not resemble any parasite known to the writer it was submitted by him to Miss Rathbun and Dr. Schmid of the National Museum for identification as crustacean or elimination from this group. Neither of them recognized it as a crustacean and Mr. Shoemaker was called into consultation. The following day Mr. Shoemaker reported that he had identified the animal as an insect head and that Mr. A. N. Caudell had identified it definitely as the head of a grasshopper, *Belocephalus subapterus.* Mr. Caudell stated that he had a similar specimen found attached to the lip of the cat. *Belocephalus* is reported by David, quoted by Caudell, as biting severely, and it seems probable from the evidence that we have here three cases, certainly two, of this grasshopper, attaching in the mouth of the cat and causing, in at least one case, serious injury and in one case, apparently, death. Many of the large orthopterons have a fairly severe bite, as Caudell has noted, but the

attachment of the jaws so firmly as to maintain the head attached to the mouth of a cat after body of the grasshopper was bitten loose from the head seem to be somewhat unusual. Dr. Chapin tells me that in New England it is believed that cats that eat grasshoppers are likely to be sickly, and Dr. Shillinger states that the same belief exists on the Eastern Shore of Maryland. Such a belief might find a basis in several things, among them cases similar to the one reported here.

Professor Hegner discussed the genus Giardia and its specificity as respects its members in their relation to hosts.

Dr. N. A. Cobb presented five nematodes notes as follows:

I. *Iota crotaloides* n. sp. and the amphids of the Triplonchs.—Nemas fixed with mercuric chlorid and mounted in glycerine jelly sometimes present birefringent artefacts inward from the vulva, anus and excretory pore—doubtless salts of mercury; i. e., various *outlets* of nemas are thus indicated. *Iota crotaloides* n. sp. presents in addition two such artefacts near the mouth, just behind two lunate lateral markings having the aspect of amphidial openings. (Text Fig. B.) Amphidial openings are often, if not always, outlets of what appear to be glands; hence the presence of this pair of artefacts is additional evidence that these minute cephalic elements of *Iota crotaloides* are the long-wondered-about amphids of the Triplonchs. The artefacts can hardly be oral, for the mouth is an entrance, not an exit; and it would be difficult to explain why there are two of them, and why they are lateral only. Previous examinations of certain Triplonchs harmonize with those of *Iota crotaloides;* thus there is a suggestive bilateral symmetry to the head of *Heterodera radicicola.* There is also a bilateral symmetry, and other indications of amphids, in the lip region of *Dolichodorus heterocephalus.*

II. *Tylenchus dipsaci* from South Africa.—Dr. Cobb called attention to the discovery of living *Tylenchus dipsaci* imported into the United States on alfalfa seed from South Africa; the significance of this importation lies in the fact that diseases of crops caused by *Tylenchus dipsaci* have been on the increase in this country for some years, having done serious damage to clover and alfalfa, and to some other important crops.

III. Minute Birefringents in Living Cells.—Speaking of the minute birefringents in the interior of living nemic cells, previously alluded to and exhibited at meetings of this society, Dr. Cobb stated that these have been further examined. Of 125 nemic genera, forty per cent. disclosed minute birefringents in the cells of the intestine. Birefringents exist in other tissues. Opportunity has occurred to seek these birefringents in other phyla, the result being to show that they exist, probably, in all phyla; failure to find them (e. g., in the echinodermata) in no wise proved them nonexistent there, as the tests were few. Similar birefringents have been seen in the cells of many plants. It seems a fair conclusion that these exceedingly minute birefringents occur throughout the organic world, not in all cells, tissues, and species, but in a specific way so numerously as to justify the broad conclusion. These birefringents vary in diameter from a very few microns down to the limits of the present microscopic resolution, and doubtless beyond. Many, perhaps the majority, are anabolic; some, no doubt the minority, are catabolic. In form they vary from spherical, or ellipsoidal, bodies surrounded by a definite membrane (plast?) through roughly polyhedral ones to crystals of the ordinary sort. Those surrounded by a membrane may exhibit a Greek or a St. Andrew's cross. Some are duplex; others even more highly compound. As to structure, they may be described as moruloid, polychondroid, duplex, citroid, radiate and crystalline. That some of them are ultramicroscopic, is indicated by the following lines of observation and reasoning: Certain living tissues, showing no birefringents, when placed between nicols, make it impossible to orientate the nicols so as to obstruct all of the light. If one imagines the presence in such tissues of a multitude of ultramicroscopic birefringents arranged in every conceivable position, then, no matter how the nicols are placed, some of the

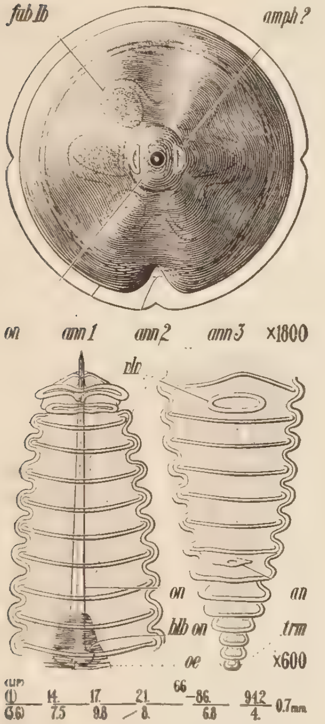


Fig. B.—*Iota crotaloides n. sp.*—Front view of the lip region showing supposed amphids; lateral view of the head end, and ventral view of the tail end of a female.

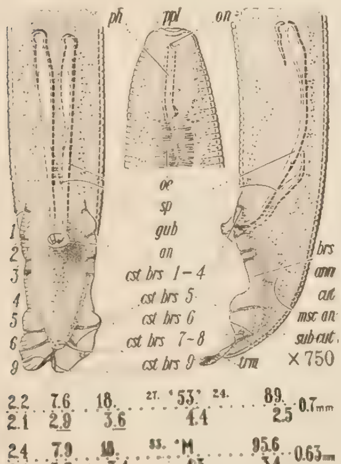


Fig. D. — *Neodiplogaster tropica n. gen., n. sp.*—Lateral view of the head; tail end of a male, ventral and lateral views.

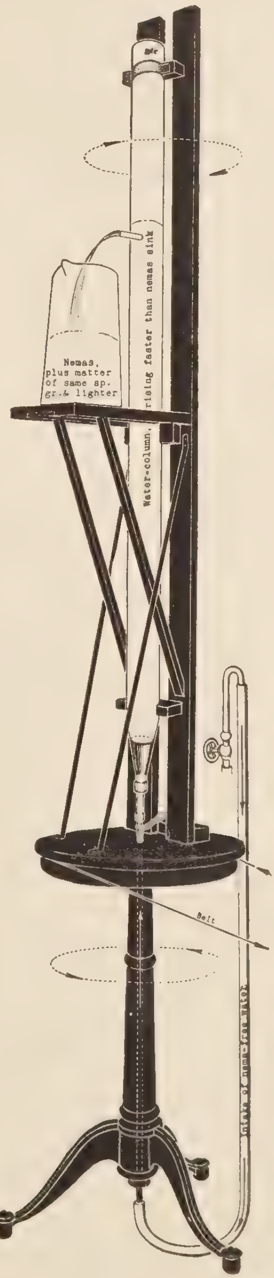


Fig. C.—Nema flotation apparatus.

birefringents will so alter the light as to let it through the second nicol. The result of this reasoning is corroborated by the examination of tissues containing a multitude of these birefringents *barely large enough to be resolved;* such tissues present the phenomenon described—that is to say, the nicols cannot be placed in a position such as to obstruct all the light. Finally, there seems no reason for supposing these birefringents to cease at the purely accidental size determined by our best present-day microscopic resolution.

These bodies occur in embryonic tissue, e. g., in the first blastomeres of a number of nemas belonging to different genera, Rhabditis, Diplogaster, etc. In some such cases the same birefringent occurs in the intestinal cells of the mother, and reappears in the blastomere which is to give rise to the intestine of the embryo. The phenomenon reminds one strongly of the translocation of starch in plants, e. g., from leaves to embryo. It even is noticeable that during reproduction the birefringents may disappear from the intestinal tissue of the mother; when she is spent, no birefringents remain. Furthermore, the birefringents disappear first from that portion of the intestine of the mother adjacent to the sexual organs. Even in the present initial stage of knowledge of these interesting bodies, they are so manifestly specific as to aid in taxonomy. For example, the genus Anticoma might be characterized thus: Marine free-living nemas, containing in the intestinal cells, numerous duplex, ellipsoidal birefringents.

Examinations thus far made justify the conclusion that some of these birefringents in each well-marked species vary from those of any other species, even those most closely related, somewhat as Reichert has shown starch and hemoglobin to vary in plant and animal species.

It is highly desirable that an apparatus more suitable to the examination of these minute birefringents be brought into use. They have not hitherto received the attention they deserve because of (1) their minuteness, and (2) the widespread tendency to hurry cytological material into fixatives. As the vast majority of these birefringents are dissolved during this process they are not to be seen in preserved material. (3) The unsuitability of present-day polariscopic apparatus. The best I have so far devised involves the use of a high power immersion lens as a condenser (practically a mate to that being used as an objective), having located almost in contact with its back lens a large nicol prism. This insures enough polarized light for an examination, even with the highest power immersion objective. The ordinary microscopic polarizing apparatus fails at this point, principally because of the disproportion in size between the nicol prism and the Abbé condenser; only that portion of the light which passes through the relatively small nicol prism goes through the condenser, namely, only a small fraction—not enough to illuminate the field of a high power lens. An effort is being made to bring into use exceedingly high power objectives, such as the 1/50 inch objective made by Powell and Leland, or more suitable ones constructed specially for this purpose, in which there shall be a very high magnification, even if resolution has to be sacrificed to some extent. The object of the arrangement will be to secure images sufficiently large so that a Bertrand lens can be used, as in petrography. Initial experiments seem to make it desirable, in some cases, to do away with the ordinary support for the object and to mount the object directly on the front of a water immersion condensing objective and to examine the birefringents without the interposition of anything except a fluid surrounding the object and lying between the condenser and the objective; the latter also water immersion. This method can be used where the number of birefringents is so great that some of them will come sufficiently near the center of the field to permit of polariscopic examination. Petrographic microscopes of the best construction are suitable for these examinations, though with the excessively high powers the alignment of the different elements of the apparatus must receive special attention, and the polarizer must be altered.

IV. Removing Nemas from Soil by Floatation.—Dr. Cobb also exhibited an apparatus designed by him for removing nemas from soil by floatation in water. The apparatus consists of a long vertical rotating tube, several inches in diameter, into which the soil containing the nemas is introduced; water is then run into the rotating tube from below, filling the tube at a rate slightly in excess of that at which nemas sink. The nemas are spouted off near the top of the tube into a receptacle revolving with the tube. (Text Figure C.).

V. *Neodiplogaster tropica n. g. (?) n. sp.*—Dr. Cobb called attention to nemic forms intermediate between Rhabditis and Diplogaster. Diplogaster, of which forty-eight species are known to him, not all published however, comprises two distinct groups of species; (1) a group of forty-one having onchia in the pharynx; (2) a group of seven with onchia obsolete, e. g., *D. bernensis* Steiner. The onchiate group may be subdivided: (*a*) nineteen with mobile onchia situated well forward, of which *D. fictor* Bastian is an example; and (*b*) twenty-two with "fixed" onchia originating near the base of the pharynx, as in *D. similis* Bütschli. (Text Figure D.) The new intermediate form, *Neodiplogaster tropica* n. sp., may be characterized as follows: New genus having in general the characters of *Diplogaster*, but with a relatively narrow pharynx armed with a single dorsal onchium near the lips, and having males supplied with a well developed rhabditoid bursa, which may completely envelop the tail. Type species *N. tropica*, from cocoa pods, Guatemala. (See Fig. D).

Dr. C. E. Simon reported on *Cases of Spurious Parasites in Malingering Patients.*

Case 1. Female; plaster in urine. Case 2. Female; red paint in urine. Case 3. Female; chicken lung; paroxysms of choking. Case 4. Female; two worms (later determined by Stiles and Brown as *Paragordius varius* male and female); in this last case, the question was left *sub judice* as to whether it represented spurious or accidental parasitism. All patients were hysterical.

Dr. E. C. Faust mentioned the possible use of tetralin (tetrahydronaphthalene) as a substitute for the clearing agents commonly used for parasitological and anatomical specimens. He has seen elaborate anatomical demonstrations cleared in this medium by European biologists and is advised by Professor O. Fuhrmann, of Neuchâtel, Switzerland, that it is both satisfactory and inexpensive. It is used commercially in Germany as a substitute for turpentine, but may now be obtained in this country in limited amounts. He demonstrated a specimen (labelled cotype) of *Artefechinostomum sufrartefex* C. Lane, loaned by the Indian Museum for study, which had been cleared in tetralin.

The seventy-second meeting was held Dec. 15, 1923.

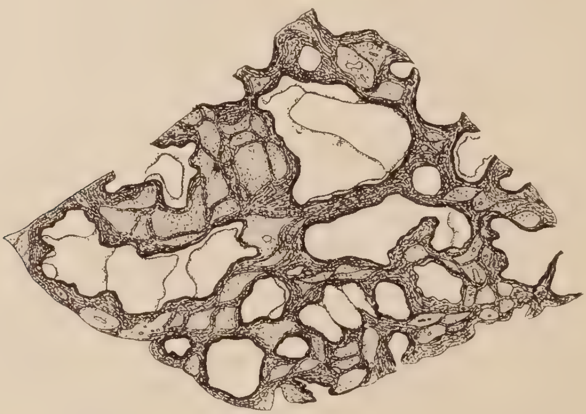
Miss E. B. Cram presented the following notes:

1. A case of Paragonimus in a cat: Specimens of *Paragonimus kellicotti* from the lung of a cat were sent to the Zoological Division for determination, from Baton Rouge, La., by Dr. Harry Morris of the Louisiana State University. The specific determination is made purely as a host determination, since authorities disagree at present as to the status of the three species *P. westermani*, *P. kellicotti* and *P. ringeri*. Cases of infestation with these flukes have been reported in this country from dogs in Ohio and California, and from cats in California, Michigan, Wisconsin, Minnesota, Missouri and West Virginia.

2. A case of massive infestation with hydatids in a pig:—The viscera of a hog condemned at Bennings, Md., for slight general icterus were submitted for examination to the Zoological Division by Dr. Walter, the inspector in charge. The lungs, spleen and liver were found to be filled with great masses of hydatid cysts. Sections were made of four different parts of the liver, in order to attempt an estimate of the relative amount of cyst material and of liver tissue. It was found that the cysts made up from 37.5 per cent. to 52.4 per cent. of the total, with an average of 47.1 per cent. In the actual tissue there was a marked increase of dense connective tissue, so that the functional liver tissue was greatly reduced even in these areas. (Text Figure E.)

Dr. Stiles raised the question as to the present status of the names *Paragonimus westermani, P. ringeri,* and *P. kellicotti* and discussed the topic. It was also discussed by Dr. Ransom, Dr. Chapin and Dr. Faust, with reference to the opinion of Ward and Hirsh, Kobayashi, and Vevers, the consensus of opinion being that the status of these names was still *sub judice*. Dr. Stiles expressed the opinion that the lung flukes from different hosts as reported under these 3 names had better be kept separate for the time being. He also noted that there was only one report of Paragonimus from man in the United States, this case being in an Asiatic. Dr. Hall raised the question as to the nature of *Distomum kalapaï,* occurring as a larva in the liver of crabs, and *Stephanolecithus parvus,* occurring as a larva on the gills of crabs, according to a footnote in Brumpt, the larvae of *Paragonimus ringeri* occurring in the muscles and hypodermis.

Dr. Stiles discussed the terms infection and infestation and the various usages were discussed by the society with no agreement reached. According to one usage, infestation applies to organisms present in large numbers and sometimes to organisms definitely injurious in the numbers present. According



Text Figure E

to another use, infestation is applied to animal parasites which do not multiply through an entire life cycle in one host animal, while infection is applied to bacteria or similar organisms multiplying in one host animal.

Dr. E. A. Chapin presented a note, with an exhibition of a specimen, on the spicules in *Syngamus laryngeus* of cattle: This species has been reported by Railliet, Sheather and Shilston, and Hall as having no spicule. Dr. Chapin finds small spicules, 25μ long and feebly chitinized. He noted that specimens of the bursa of this species and specimens of an echinorhynch were mounted in fluid consisting of equal parts absolute alcohol and phenol and ringed with gold size, and that the gold size ran into the mount giving a satisfactory mount in gold size.

In comment Dr. Faust noted that *Syngamus trachealis* was reported by a Baltimore physician, Dr. Wiesenthal, in 1799 and that a copy of his article had been filed with the coat of arms of the Wiesenthal family in the School of Medicine of Johns Hopkins University. Dr. Hall noted that in a paper previously presented before the society he had called attention to the progressive atrophy of the spicules in Syngamus in association with an increasingly close and permanent union of the male and female, and that the small spicules of *S. laryngeus* fell into this arrangement. In this connection Dr. Chapin noted

that he had a new species of Syngamus from the hawk, in which the sexes were separate as collected and where the union was evidently of the temporary type common among strongyles.

Dr. E. C. Faust presented a note on The Known Distribution of the Molluscan Hosts of *Schistosoma japonicum* in the Far East Considered in the Light of the Known Distribution of Schistosomiasis Japonica, by Ernest Carroll Faust and Henry Edmund Meleney, of the Peking Union Medical College:

Three or more closely related species of molluscs belonging to the family Rissoidae have been collected from the Sino-Japanese areas which are known experimentally to be actual or potential intermediate hosts of *Schistosoma japonicum.* In Japan the species is *Katayama nosophora* Robson (not *Blanfordia japonica* A. Adams, which is an entirely different form that has not been described from the endemic areas). In a private communication to us Professor H. Kobayashi lists *Katayama nosophora* from the five areas endemic for schistosomiasis in Japan, i. e., Katayama district, Yamanashi district, Lake Ukishima district, Toné River district, all on the main Island; and Sage Prefecture on Kyushu. In addition this species is said to have been collected in Saitama Prefecture near the Ara River, to the north of the endemic areas. This same species (identification of Dr. Nelson Annandale) has been collected from an endemic area near Shaohsing, Chekiang Province, China, and in another area, near Canton, where the disease is not known to be present. Dr. Kobayashi states that in his own observations in Japan, "there are, at least, two varieties (or races) as distinguished by the form of the shell of this snail: one being longer and more slender, occurring in Saga Prefecture (Kyushu) and the Katayama district; the other being somewhat thicker, occurring in Yamanashi, Toné (and perhaps Lake Ukishima) districts." The Chinese forms may be still different subspecies. In Formosa one area alone has been investigated, that of Shinchiku, near the center of the island, where *Katayama formosana* has been collected. In the Yangtze Valley and adjacent lakes and canal systems in China *Oncomelania hupensis* Gredler has been collected as follows: Kiangsu Province (Yangtze delta, Great Lake and Grand Canal, four centers, collections made by Heude and by Meleney); Chekiang Province (Kashing area, collection by Faust); Kiangsi Province (Heude); Hupeh Province (Gredler); Hunan Province (Heude); Szechuan Province (?) (Heude).

These forms are all amphibious in habits. They are not found in large or swift bodies of water, but in among the grass and weeds and moist humus of overhanging banks along terminal canals and quiet coves. They are also found in the rice nursery beds and (in Japan) along the irrigation ditches of rice fields during the spring and summer. The snails do not live in clayey soil, but can usually be located near freshly deposited human fertilizer. The region north of the Yangtze Valley is incompatible to their existence. They have not been found in Korea (*fide* Kobayashi). They have not yet been collected from the Philippines. The Katayama species appear to live only in mountain-stream water, while the Oncomelanias have been found only in water with a considerable lime supply.

Schistosomiasis japonica has a distribution in Japan, China and Formosa corresponding very closely to the probable distribution of the molluscs. The Ara River district in Japan and the Canton area in China are not known to be endemic for the infection but constitute potential areas of schistosomiasis japonica. *A priori,* the disease cannot secure a foothold where these snails or closely related forms cannot live.

Dr. N. A. Cobb presented the following *Observations on Nemas.*

I. Nemas on Commercial Seed.—An examination of red clover seed, (1) as threshed, (2) cleaned, (3) recleaned and (4) cleaned a third time, disclosed a practical detail in tracing disease caused by *Tylenchus dipsaci.* Samples of seed kept soaked and thoroughly washed daily for seven days continued in some cases to yield additional nemas up to the seventh day. This applied

not only to *Tylenchus dipsaci* but to five other species, another *Tylenchus* and members of four other genera—Aphelenchus (alive), Cephalobus (alive) Dorylaimus and Xiphinema. Certain samples of seed which yielded no nemas after the first, and second, and third washing *yielded them in later washings,* the nemas having been in some manner held tenaciously to the seed. In such instances a decision as to the presence of nemas reached on the basis of the earlier washings would have been erroneous. While the observations reported are restricted to clover seed, similar conditions prevail in connection with other kinds of seed. There are many different kinds of seeds in commerce, which, on being washed, yield nemas, often in a living condition.

II. Amended Characterization of the Nemic Genera Cephalobus and Acrobeles.—A recent review of my file of fifty-one species of Cephalobus and twenty-six species of Acrobeles, the great majority new and as yet unpublished, but including all the known species, shows that the *Cephalobus-Acrobeles* "series" may be conveniently, and probably naturally, divided into, (1) Species with a single circlet of labial organs; (2) species with an inner, as well as an outer, circlet of labial organs.

Cephalobus Bastian amend. Lip region 3, or 6, lobed, with 3, or 6, labial papillae in single circlet. Spinneret none. Naked integument transversely striate. Pharyngeal cavity inversely triquetrous-pyramidal; its wall usually composed of longitudinal series of a few small, short, disjoined, cuticular elements; no onchium. Esophagus in anterior half cylindroid, then narrowed; finally enlarging to form more or less pyriform cardiac bulb containing threefold striated valve; medidan esophageal bulb absent or vestigial. 'F'; ovary reflexed past the vulva, which is usually near latitude 66°. Spicules two, equal, curved; gubernaculum median, easily recognizable. No bursa; preanal and postanal submedian or sublateral papillae present, the full complement being about nine pairs. Amphids mostly unknown; where known, far forward and very inconspicuous. Type species, *C. persegnis* Bastian, 1865.

Acrobeles von Linstow amend. Characters of Cephalobus Bastian amend, but having also a second inner circlet of labial organs, often simple and conoid, sometimes relatively long and branched, in which case the outer may also become compound. Pharynx narrower, and uniform, with fewer separate cuticular elements. Amphids though small usually visible, transversely elongate, on outer surface of lip region. Type species, *A. ciliatus* von Linstow 1877.

The future may very probably disclose reasons for subdividing Acrobeles as thus defined and designating separately a group (Acrobeloides gen. [aut subg.] nov.) between Cephalobus and Acrobeles sensu restricto,—characterized by having the inner and outer circlets of labial organs simple.

III. Amphids of the Oxyurids.—While the location of the Oxyurid amphids has been known for half a century, that is to say on *Oxyuris curvula,* they have not been recognized as such until recently, but have been regarded as labial papillae of a somewhat different character. Later researches have shown them to be connected by means of nerve strands with the central nervous system (Martini in *O. curvula),* and it has been stated that they are the homologues of the amphids of the free-living nemas, though there were some gaps (or weaknesses) in the evidence. Front views of the head ends of a number of Oxyuridae show amphids to be uniformly present, and that their structure is of a typical character. In *curvula* the rather numerous terminals are readily visible.

IV. Specialization in the Cells of the Intestine of Nemas.—Perhaps thought is seldom given to the matter, but, when it is, I suspect the cells of the nemic intestine are considered to be more or less uniform in structure and function. This is far from being the case. Cells, singly and in groups, in various parts of the intestine are often highly specialized, and always more or less so. This difference in structure and function can be demonstrated in various ways: (1) by the ordinary methods of staining such as are used when specimens are mounted in balsam; (2) by means of intra-vitam staining; (3) by the applica-

tion of polarized light; (4) by subsequent examination in more ordinary ways under the stimulus and enlightenment of one or more of the preceding methods. A species of Rhabditis recently discovered by Dr. G. Steiner exhibits an interesting form of this specialization. The cells composing the middle portion of the intestine are distinctly set off, suddenly, from preceding and succeeding cells by the fact that they are packed with birefringent spherical granules, whose internal structure may be roughly compared to that of bread fruit. This group of cells is located opposite the early stages of the sexual cells. No such distribution of birefringents has hitherto been seen in the intestine of Rhabditis. It is not certain whether this is a stage in the distribution of the birefringents characteristic of only the young form of this species, or whether it is a permanent feature; in either case it is a striking illustration of the specialization alluded to in the opening sentences of this paragraph.

V. Small Syracuse Watchglasses.—Attention is called to the fact that there is now being manufactured a small sized Syracuse watchglass, a replica of the ordinary nesting Syracuse watchglass, but having a capacity of 1 c.c. These smaller glasses stack and have all the conveniences of the standard Syracuse watchglass. For certain work they present advantages over the standard size. 1. Being smaller and lighter, they save space and are more portable. 2. On account of their small content they effect a saving in expensive fluids. 3. For the same reason, they effect a saving in one's time when searching for a microscopic object under treatment, since the area to be searched is some ten times smaller.

Dr. B. Schwartz reported for the first time the occurrence of *Eimeria falciformis* in the United States, the parasite occurring in a white rat in Washington. This parasite was originally described from the mouse and has been reported from mice, rats and rabbits. It normally occurs in the epithelial cells of the intestine, but has been reported from the kidney of horses on one occasion, with the death of three horses attributed to it. Dr. Schwartz is doubtful of the validity of the record from the horse. He also reported for the first time the occurrence in the United States of *Heterakis isolonche* in nodules in the ceca of pheasants from Pennsylvania, the material having been forwarded by Dr. Boerner. The parasites were apparently fully grown but immature. This species is known from Europe and has been regarded as responsible for the death of pheasants. The worm may mature in the nodules, all stages having been found there by various observers. The reports of *H. gallinae (H. papillosa)* as occurring in pheasants or as forming nodules in chickens appear to be erroneous.

Dr. Schwartz also reported *Metastrongylus salmi* from swine in the United States and the Philippines, and notes that specimens collected by Foster in the Bureau of Animal Industry in 1913 had been filed by him with the label *Metastrongylus* n. sp. There are only some minor discrepancies between the material found and the description given by Gedoelst. Dr. Stiles noted that Eimera was reported by Pfeiffer, based on a stage of Coccidium. Labbé did not accept this. Later Labbé proposed the genus Pfeifferia, also based on the Eimeria stage of Coccidium. Pfeifferia was preoccupied in molluscs, so Labbé changed the name to Pfeifferella, a name now occasionally quoted but of doubtful validity. Dr. Stiles also noted that the Bureau of the Census was interested in the 1930 Congress of Hygiene and Demography with reference to a standardization of the nomenclature of parasites and diseases due to them and would welcome the cooperation of the Public Health Service, the Department of Agriculture, and the Helminthological Society in this connection.

The seventy-third meeting was held Jan. 19, 1924.

Dr. E. A. Chapin called attention to the citation by A. C. Walton (Jour. Parasitology, 10:61, Dec., 1923) of a European species of vole as collected at Urbana, Illinois.—The species in question, *Microtus arvalis,* has not, up to this time, been reported from this continent and an error of determination is probable. The importance of accurate host determinations was stressed

This communication was discussed by Hegner, Metcalf, and Stiles. Dr. Hegner related the reported finding of Opalina in the adult green frogs of this country (*fide* Kudo) while neither Hegner nor Metcalf had been able to find it in this adult. Dr. Stiles made the point that in general the report of a given parasite in a given host is subject to considerable theoretical and practical error. For instance, there may be an erroneous specific determination of either the parasite or the host or both; or a given species, parasite or host, may later be divided into several species, thereby decreasing the specific value of the reported presence of a given parasite species in a given host species. Authors removed from opportunity to consult systematists in various groups are at a special disadvantage in respect to the host species. Again, different generic and different specific concepts come into consideration. Further, also, some authors report hosts by a vernacular name, as "cattle," "sheep," or "chimpanzee," while later authors assume that a given species of *Bos, Ovis,* or *Pan* was the one in question. The natural conclusion is to view all lists of host records of parasites and disease as subject to considerable latitude in possible interpretation and when dealing with a case from a public health point of view it will generally be on the side of conservatism to grant to an infection a much greater potential host latitude than that actually reported. In the case of malaria, for instance, it is a safer although a more expensive policy to consider all species of Anopheles as vectors; and in the case of yellow fever, all species of Stegomyia should be considered as guilty until proved to be innocent. In the last analysis, however, the theoretical potentialities must, of course, not ignore the financial possibilities.

Dr. C. W. Stiles and Miss S. C. Smith presented a note entitled: *Trypanosoma gambiense* designated as type species of Trypanozoon Lühe, 1906.—The possibility is present for a serious confusion in the medicozoological nomenclature of the trypanosomes, due to the fact that Lühe appears not to have designated the genotype of Trypanozoon, which (1906: 92) he proposed for the trypanosomes of mammals. He mentioned especially *Trypanozoon lewisi* as the best known species, *Trypanozoon gambiense* as a species of practical importance because of its cause of sleeping sickness in man, and *Trypanozoon brucei,* the cause of nagana. Lühe was of the opinion that the time was not opportune for designation of genotypes. In this latter view it is not possible for us to concur and, in the hope of forestalling confusion in nomenclature, we herewith designate as genotype the species *Trypanozoon gambiense* Dutton, 1902, cause of African sleeping sickness in man. This action definitely reduces to synonymy the name *Castellanella* Chalmers, 1918, type *T. gambiense.*

Dr. N. A. Cobb presented the following: Notes on the Amphids of Nemas.

The amphids of Iota.—At a recent meeting of the society, I called attention to the position and size of suspected amphids of Iota, as indicated by the appearance near the mouth opening of birefringent artefacts indicating exits. Those observations have been confirmed by an examination of the head end of *Iota peruense* Steiner. (Text Figures F. G.) On this species, in the corresponding position, minute organs have been seen having the characteristic appearance of amphids. Externally they may be seen close to the mouth as lateral openings, elongated dorsoventrally and directed forward. In the tissues just behind each of these openings are six or seven such terminals as are characteristic of amphids. These supposed minute amphids are rather difficult to see, at any rate in specimens fixed with Flemming's solution and mounted in glycerine jelly. Viewed externally from in front, they measure 2μ by about 0.5μ; the very minute terminals contained in them are near the limits of microscopic resolution.

The amphids of Strongyloides.—The amphids of Strongyloides are a good illustration of the rather close external resemblance that may exist between amphids and labial papillae. Following backward in three successive sections, beginning near the front surface of the head of a strongyloides larva, it is readily seen that the lateral "papillae," which at the surface bear considerable

resemblance to the four submedian papillae, are really very different; for while each submedian papilla proves to be supplied from behind with the more ordinary, narrow nervous element, the amphids in corresponding latitudes, not far behind the front surface of the head, are very much expanded and present a variety of constituent elements. The observations were made on the larvae of a Strongyloides from the feces of the Chimpanzee. (Text Figure H.)

Dr. C. W. Stiles and Miss S. C. Smith presented a note entitled: *Balantidium entozoon* the Type Species of Balantidium Claparède and Lachmann, 1858.—In an interesting and valuable paper by Buisson* (1923:233), *Balantidium coli* (Malmsten 1857) of Homo is cited as type of Balantidium C. and L., 1858. This same species is cited also by Apstein (1915a:122) as the type species of this genus.

In order to forestall possible confusion in the medicozoological nomenclature of balantidial diarrhea of man, attention is invited to the fact that Claparède and Lachmann (1858b:247) based their genus upon a single species,

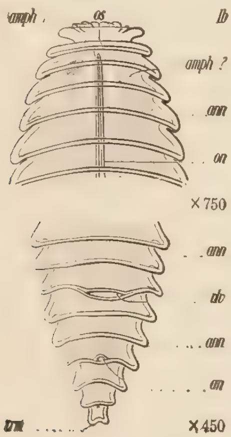


Fig. F. — *Iota peruense* (Steiner). Lateral view of the head end; ventral view of the tail end of a female.

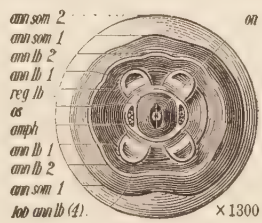


Fig. G. — *Iota peruense* (Steiner). Front view of the lip region, showing what appear to be amphids containing a number of terminals.

namely, *B. entozoon* (Ehrenberg, 1838b:327 [Bursaria]) C. and L., 1858b:247; pl. 13, fig. 2, (?syn. *Paramaecium nucleus* Schrank, 1803b:67) for which *Rana temporaria* is the type host, with Berlin, Germany, as type locality; they placed *B. coli* in the genus Plagiotoma, and they (p. 241) consider *Paramaecium nucleus* Schrank (1803:67) from frogs, an Opalina. Accordingly, under Article 30c of the International Rules on Zoological Nomenclature, *B. entozoon* is the genotype, and under Article 30e, *a Balantidium coli* is excluded as genotype of Balantidium. We have verified the original references concerned, and find that the generic name *Balantidium,* type *entozoon,* is available and valid under the International Rules. As an important genus of medical interest is involved, it would be well if this generic name, as thus definitely fixed by genotype, were added to the Official List of Generic Names.

Mr. J. R. Christie presented a general review of his studies on the Embryology of *Agameris decaudata.*—While the females of *Agamermis decaudata* vary in length from some 6 cm. to 45 cm. or over, there are no corresponding variations in the size of the eggs, which average about 166μ in diameter, except in the

* Sur quelques infusoires nouveaux ou peu connus parasites des mammifères Ann. de Parasit., v. I (3), 209-246, figs. 1-21.

case of females around 12 cm. or less in length, where the eggs average about 122μ. With reference to size, therefore, the eggs fall into two fairly well-defined groups. In general, the cleavage resembles that already known for other nematodes. Near the head of a twenty-five day embryo the developing esophagus can be seen. From a spindle-shaped rudiment, contained in a vesicle and lying in the esophagus at about the position it is destined to occupy, the "spear-head" is formed. In a somewhat similar manner the "shaft" is later developed and the two unite to form the complete onchium. The larvae moult once within the egg shell. When they are kept in soil having a temperature of about 18 C., this moult starts at the end of five to six weeks and is complete in about twelve weeks. Irrespective of when eggs are deposited, few larvae leave the egg before the following spring. (Text Figure H.) The paper was discussed by Chapin, Cobb, Steiner, and Stiles.

Dr. G. Steiner exhibited drawings of a number of Mermithids from Paraguay, collected by Fiebrig. Five different species were present, namely, *Mermis nigrescens* Duj., *Agamermis decaudata* Cobb, Steiner and Christie, var. *paraguayensis* n. var., *Agamermis angusticephala* n. sp., *Agamermis dubia* n. sp. and *Hexamermis meridionalis* n. g. n. sp.

Dr. Steiner also spoke on the relationship of the Mermithidae to the free-living nema family of the Dorylaimidae and outlined a classification of the Mermithidae based upon lines of specialization followed by different groups of the mermithid family. The influence of parasitism upon the organization of the mermithid body, its physiological and etiological behavior and the steps of gradual progressive specialization and adaptation were sketched. Both papers will be published in extenso elsewhere.

The seventy-fourth meeting was held on Feb. 16, 1924.

It was voted to offer the following generic names of parasitic protozoa to the International Commission on Nomenclature for inclusion on the list of accepted generic names:

Endamoeba Leidy, 1879a : 300, mt. *blattae* Bütschli, 1878a : 273, t.h. *Blatta orientalis.*

Giardia Kunstler, 1882, CrAS, 95 : 349, mt. *G. agilis* Kunstler, 1882 : 349, in intestine of tadpole of *Rana.*

Trichomonas (Donné, 1837) Ehrenb., 1838a : 331 (emendation of Tricomonas).

Trypanosoma Gruby, 1843a : 1134, mt. *T. sanguinis* Gruby, 1843a, Nov. 13—*Amoeba rotatoria* Mayer, 1843, in blood of Rana.

Balantidium Clap. and Lachm., 1858b : 247, mt. *Bursaria entozoon* Ehrenb., 1838b : 327.

Dr. M. C. Hall exhibited a specimen of a final stage larva of *Bogeria* sp. passed in feces by a dog.—The specimen was sent from McNeill, Miss., by S. W. Greene, and was badly macerated internally and much distended with gas. It was said to have been alive when passed; this seems doubtful. It has been surmised, probably correctly, that dogs and cats can become infected with Cuterebrids by eating rodent or rabbit hosts containing first stage larvae. Evidently last stage larvae pass the digestive tract of carnivores without infesting them when such larvae are eaten with the original hosts. It was also noted that four unreported cases of Cuterebrids in dogs have occurred in the practice of Dr. LaCroix, at Chicago, Ill., who states that the larvae usually occur in the throat region of the host.

Dr. E. C. Faust spoke on the problem of: What Constitutes a Justifiable Basis for Systematic Grouping of Larval Trematodes?

There are four possible procedures in determining the systematic position of a cercaria. 1. Complete experimental proof of the life cycle of the larval form. This is the most desirable method and, if the structure of the organism during the several phases in the life cycle is adequately worked out, this constitutes not only a convincing proof, but makes it possible from the behavior of homologous organs during development to gain information regarding the

systematic position of closely related forms. (Advocated by Leiper.) 2. By studying those organs and systems of structure in the larva and adult which are least modified in development one may predict from the larva with a fair degree of accuracy what the probable adult form will be. 3. From a knowledge of (1) and (2) one may predict the position of a larval form closely related to one having a known life history even when only the larval (and ephemeral) characters of the two comparable forms are known. 4. One may construct a complete nomenclature for the larvae, attempting to place them in related groups wholly on the basis of larval characters and entirely independent of the life cycle (Lühe's classification).

If the experimental proof of the relation of the cercaria with the adult fluke were as easy as the description and naming of the larval species, there would be little reason for the presentation of these data. Unfortunately

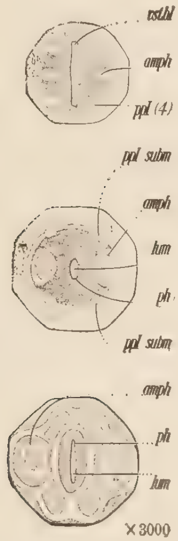


Fig. H.—Three views at the lip region of a Strongyloides of the Chimpanzee. Upper, front view of the lip region; middle and lower, successive optical sections immediately behind the lip region.

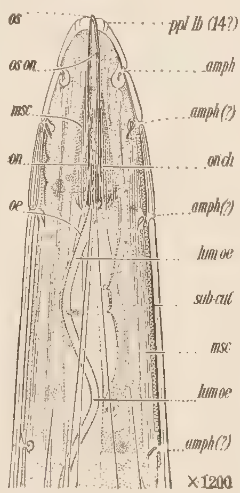


Fig. I.—Dorso-ventral view of the head end of the larva of *Agamermis decaudata.*

in the past, life history investigations on trematode species have been undertaken purely on a trial and error basis and in some cases the discovery of the genetic relationship of larvae and adults has been pure accident. In such cases structural and morphological information has been minimized. A study of the larval characters of the trematodes for some years has brought me to the conclusion that there is only one common system carried over from the cercaria to the adult, which is sufficiently definite and conservative as to be utilizable for purposes of group identification. That system is the excretory system. The more work that is done in this system, the more indicative is it of possessing value as a natural basis of classification, and the more evident is the artificiality of some of Lühe's groupings of larval forms and of the equal artificiality of some of the families of adult trematodes that have been created. While the study of adult correlations with known larval forms is still in its infancy, it is not too much to state that all members of a natural adult group possess the same basic excretory pattern. There is no better

exemplification of this than in the group of the human schistosomes where the excretory system in all three species of larvae is known to be identical and where the pattern in the adults is known to be a geometrical elaboration of this fundamental pattern in the larva. If, therefore, the correlation of one species of cercaria and adult trematode is known, it follows that other cercariae, having similar although specifically different larval characters, including the excretory or solenocyte pattern, belong to the same natural group.

In the family Schistosomatidae so many larval species are known while so little is known of the adult forms outside of the three human blood flukes, that correlation will be practically futile until more life cycles are experimentally proved or until more solenocyte patterns for the adults are worked out. It is evident, however, from the present status of knowledge relating to the excretory system of the cercariae of this group that the number of natural adult genera (possibly of the subfamilies of the group) must be tremendous, since the solenocyte patterns of the cercariae is astonishingly large. The fundamental basic pattern is identical in all of these forms, namely, an anterior and a posterior eusolenocyte, for each side of the body. However, there are two important subgroups, consisting on the one hand of those species in which the next divisional unit is twined and those in which it is a triplet group. The human schistosomes and the species most closely related to them belong to the first category. In the echinostomes the fundamental unit is consistently a triplet group. In the Fasciolinae it consists of an anterior and a posterior group of two solenocytes which divide geometrically four times up to the mature cercarial stage. The megalurous cercariae (adult stage not known) have an anterior quartet and a posterior triplet group for each half of the body. The cystocercous cercariae (adult stage not known) have a flame-cell formula which is expressed as $2 [(2 \times 4 \times 4) \times 4 + (2 \times 4 \times 4) \times 4]$. The paramphistome group is represented by an initial triploid pattern as follows: $2 (8 + 1 + 16)$; and the Diplodiscinae, as indicated by the formula in *Diplodiscus subclavatus,* have a four-fold pattern, namely $2 (3 + 2 + 2 + 8$ [or $9])$. The notocotylid monostomes have a basic formula of $2 ([2 + 2] + 2)$. The other monostomes are "unknowns."

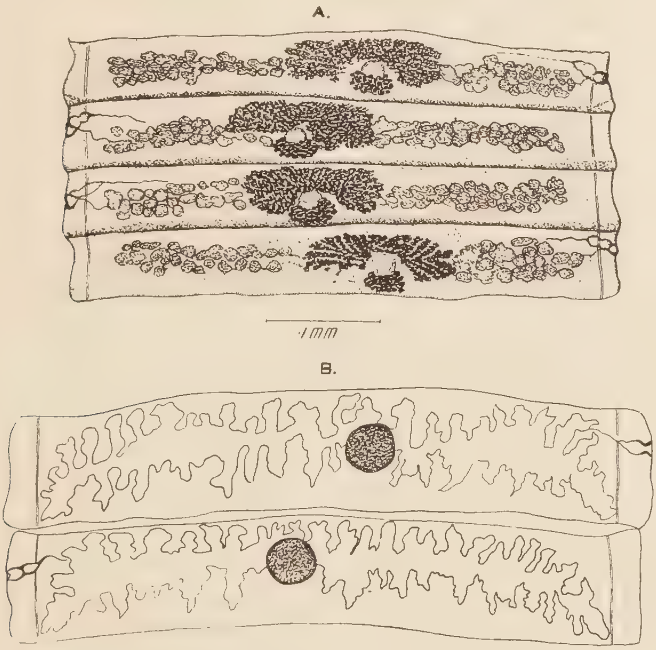
Perhaps the most valuable aid that the excretory pattern has furnished in demonstrating correlations between cercariae and adults is in the Xiphidiocercariae (Lühe's classification). Various workers in this group have recognized the artificiality of the group but have had little to offer as a substitute. Due to the recent studies of Sewell (1922) and to some of my unpublished studies data are now available to initiate this change, almost wholly on the basis of the excretory system. As a group the Xiphidiocercariae for which the solenocyte pattern is known may be divided into successive assemblages, in which the first and most simple one possesses a pattern consisting of one anterior and one posterior paired or triploid group of flame-cells. By the interpolation of binary division of one or both of these units such a simple pattern gives rise to more complex patterns until a fairly elaborate system obtains. In such a classification the Allocreadiinae and Stephanophialinae represent amplifications of a relatively simple system, the Gymnophallinae, Microphallinae and Lecithodendriinae occupy a middle position, and the Dicrocoeliinae, Plagiorchiinae, Brachycoeliinae (?), and Mesocoeliinae represent a more complex type of pattern. Many intermediate positions are occupied by cercariae of which the life cycles are not known. In no case does the new system vitiate known natural classifications of adult forms; it rather serves to confirm their relationships.

It is felt, therefore, that with the additional data accumulating on larval trematodes there is more and more opportunity of bringing about a natural classification of such forms, making use of the excretory system as the main underlying connection between the several species of larvae on the one hand and between larvae and adults on the other. The ultimate aim of such a system worked out on these lines is, first of all, to construct a reliable frame-

work for the classification of the larval flukes, secondly, to correlate this with a natural system of classification of adult forms; and, finally, with this accomplished, to make it possible for future workers on either larval or adult trematodes by a comparison of characters to predict with considerable certainty the life history of such forms.

Miss E. B. Cram gave the following note on: The Presence of *Bertiella delafondi* in the Pigeon (*Columba domestica*) in the United States.

Three large tapeworms, each 15 cm. long, were collected from a pigeon and sent in for determination by Dr. Lee M. Roderick of the North Dakota Agricultural College. They proved to be *Bertiella delafondi,* which has not been reported previously from this country. This finding make its distribution



Bertiella delafondi
A. Mature segments. B. Gravid segments.

Text Figure J

world wide as it has been found in Europe, Asia, Australia, Africa, and South America. Stained segments of the tapeworm present a striking appearance. They are very broad and short, and possess a single set of genitalia which show an unusual shifting to one and then the other side of the central line, being always nearer the poral than the aporal margin (Text Figure J).

Dr. Cobb noted that in the preparation of cestodes and trematodes, if pressure between glasses is applied carefully before and during fixation, fine thin mounts can be obtained.

Dr. E. A. Chapin discussed the symmetry of the buccal teeth in the genera Syngamus and Cyathostoma.—It is found that the normal number of teeth in the former is eight, five of which are equal in size and larger than the remaining three. In some specimens nine teeth were evident, the ninth being produced by division of the median dorsal (a large tooth) into two teeth. On the other hand, in Cyathostoma the normal is six, with an occasional

seven toothed form. In the seven toothed specimen examined, the symmetry was destroyed, since the doubling occurred in a submedian tooth and on one side only. Dr. Cobb commented on the value of the study of the buccal teeth of these and other genera of nemas.

Dr. N. A. Cobb presented the following note: Food of Rhabdites and Their Relatives, with descriptions of two New Rhabdites and a New Rhabditoid Genus.

1. *Rhabditis impar* n. sp., found by Dr. Charles Thom in cultures of microphytes derived from fermented bagasse from Louisiana, was shown to contain in the intestine spores of Trichoderma as the principal, if not the only, ingested food. The formula follows:

$$\begin{array}{cccccc} 1.7 & 13.5 & \_21. & {}^{24}\text{'}53. & 81. & \\ \cdots\cdots & \cdots\cdots & \cdots\cdots & \cdots\cdots & \cdots\cdots & 0.8\text{mm} \\ 2.2 & 4. & /\underline{4.7} & 4.7 & 2.2 & \end{array}$$

Somewhat closely resembles *Rhabditis australis* Cobb.
The following differences are noted: I. The head of *australis* is more pointed; 2. It has distinct lips, which *impar* has not; 3. Its labial papillae are more distinct; 4. Its pharynx tapers somewhat at the base; 5. Its esophagus seems considerably narrower; 6. Its rectum is shorter; 7. Its ovary is said to extend back to near the anus. The present species belongs to the smaller group of rhabdites, having a single ovary extending forward and then being reflexed.

2. *Rhabditis parateres* n. sp., found by Dr. C. A. Bentz, Buffalo, N. Y., Health Service, feeding upon slimy celery, was shown to contain normally in its intestine the mycelium of a fungus (sp. ?) no doubt associated with the decay of the celery. The anterior half of the intestine was fully occupied by mycelium arranged in an orderly way such as to make impossible any other conclusion than that the mycelium had grown after being ingested. The strands of the mycelium were very regularly arranged in a manner reminiscent of a twisted skein of yarn with one half cut away, the loose ends of the mycelium being caudad. It is interesting in this connection to note that specimens of a species of Rhabditis, not satisfactorily separable from this species on morphological grounds, has been previously collected by Dr. Charles W. Stiles from the fresh feces of a patient. (Text Figure K.) Dr. Cobb also called attention to the results of studies made during the preparation of a monograph of the rhabdites he has in hand, which showed that species of rhabdites and other microbivorous nemas were very important secondary agents in the production of humus, for instance on fields of sugar cane after harvest, where the decay of the left-over trash is much hastened by the cooperation of nemas which feed upon, and expedite the distribution of, the micro-organisms responsible for the production of the humus.

Rhabditis parateres n. sp., Size and other characters given in the accompanying illustration. Bursal formula as follows; 1;1(1); 1-1, 2,2,1; closely resembles *Rhabditis teres* Schneider. See Fig. K for labial characters.

Cheilobus n. g. Syngonic species—males unknown—having the general characters of Rhabditis, and in fact hitherto referred to Rhabditis, (e. g., *Rhabditis schneideri* Bütschli 1873). Differs materially from Rhabditis, however, in the formation of the lips and pharynx, as set forth in the accompanying illustrations and measurements, which show the characters of the type species,

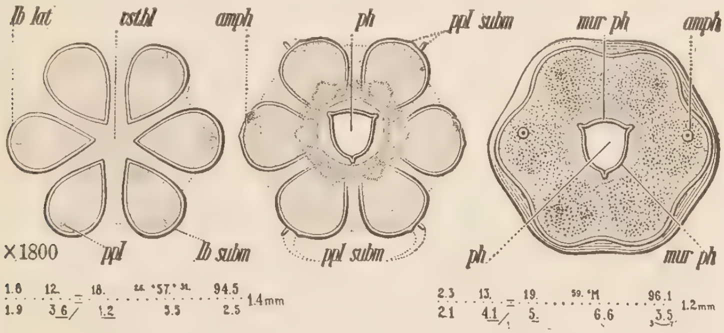
Cheilobus quadrilabiatus n. g. n. sp., a form closely related to the rhabdites, feeds upon the bacteria of slimy celery. (Text Figure ~~N~~.) M/

Dr. Cobb called attention to the fact that neither species of *Cheilobus*, —neither *quadrilabiatus nor schneideri*—is thus far known to be represented by any but female forms. Schneider, Bütschli, and Maupas deny the existence in *Cheilobus schneideri* (Bütschli) of syngonic sperm. No such sperm has as

yet been seen in *quadrilabiatus.* Should further research corroborate previous observations, then the gonic cells of *Cheilobus* would be a proper field for researches with regard to cryptogenesis.

The seventy-fifth meeting was held March 15, 1924.

Miss E. B. Cram presented a note on certain phases of the life history of a spirurid. Nematode larvae collected in Dr. Cobb's laboratory from dung beetles of the species *Pinotus carolinus* were supplied by Dr. Cobb to the Zoological Division and were fed to various animals in the hope of finding the definitive host and of obtaining the adult nematodes. The experiments were unsuccessful in that, but in certain of the animals the larvae became encysted in the walls of the alimentary tract. This observation is in harmony with the observations by Seurat which showed that encapsulated larvae when ingested by an animal other than the normal host of the adult parasite will again encyst in the wall of the digestive tract of the accidental host. This was demonstrated by him with *Spirocerca sanguinolenta* and *Physocephalus sexalatus,* the larvae of these nematodes becoming encysted in the mouse. In



Text Figure K

Fig. K.—*Rhabditis parateres* n. sp.—At the left, front view of the lip region; middle and right, successive optical sections immediately behind the lip region, showing the existence and location of amphids.

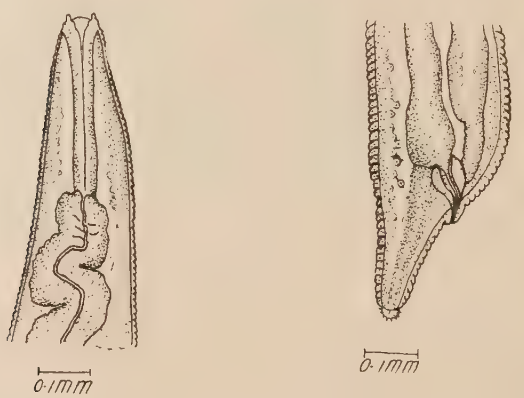
the present experiments, the larvae from *Pinotus carolinus* were found again in the walls of the digestive tract of a pigeon, a guinea-pig, and a frog. In the pigeon, which was killed fifty-four days after feeding, the larvae were found in the esophagus and crop; in the guinea-pig, fifty-eight days after feeding, in the stomach, and in the frog, forty-six days after feeding, in the stomach and rectum. The cysts were oval in shape, varying in size from 300 by 332 to 464 by 515μ. The larvae were 1.3 to 1.6 mm. in length, coiled in a spiral within the capsule. They had the elongated buccal cavity (Text Figure L) and the tail terminating in a knob bearing numerous spines similar to the larvae of Physocephalus as pictured by Seurat. The larvae had not increased in size in these hosts, as when collected by Dr. Cobb and described by him in manuscript, their average was 1.5 mm. in length.

The finding of the larvae in these three experimental animals, representing amphibians, birds and mammals, shows in what a wide range of hosts this encapsulation is possible. It emphasizes the desirability of a thorough study of encapsuled larvae whenever found during postmortem examinations of animals; if found along with adult parasites the tendency has been, as Seurat points out, for the helminthologist to consider them as different stages of the same parasite, whereas the larvae, as in these cases, may be some which have encapsuled in an abnormal host.

Dr. N. A. Cobb presented four notes:

1. The amphids of Caconema (nom. nov.) and of other nemas.—The occurrence of amphid-like structures of very small size, located close to the mouth and directed forward, in two species of Iota, led to the examination of the oral region of other Triplonchs to determine the presence or absence of amphid-like structures near the mouth. The examinations led to the discovery of amphidial structures in *Caconema (Heterodera) radicicola, Tylenchus robustus* and *Hoplolaimus coronatus*; to which must be added *Dolichodorus heterocephalus,* in which they had been previously seen and figured but insufficiently understood to justify definite designation.

The general arrangement of the structures in *Caconema radicicola* is as follows: Next to the mouth are amphidial openings, like those of Iota, leading into amphidial "sacs," which narrow considerably opposite to and just behind the labial framework, and afterward again widen somewhat and lead back without much further variation to a definite swollen portion (contained in a tunica?) lying about opposite the base of the onchium. In this elongated swollen portion of the amphid about ten slightly fusiform strands may be seen, each of which may be definitely darkened by osmic acid. While these fiber-swellings are located in a definite exanded portion of the inner amphid,

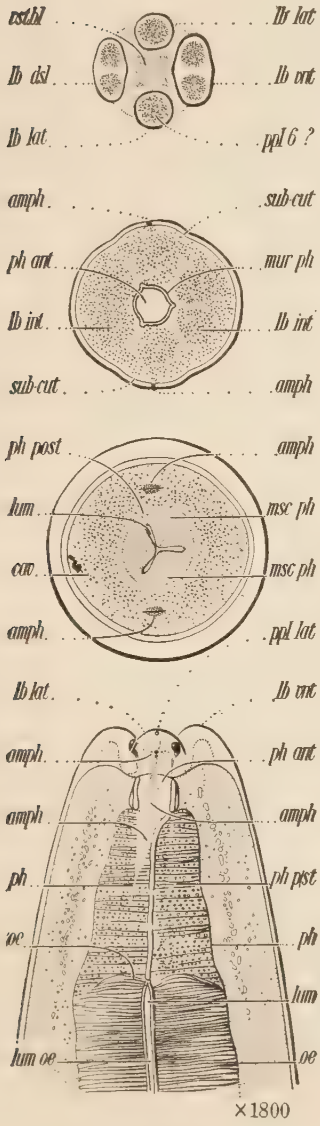


Larval spirurid.

Text Figure L

they are not all in exactly the same latitude, nor are they all of the same size. They appear rather to form a slightly rambling spindle-shaped group, having the morphology of a "taste-bud," such as those of insects and higher animals. Behind the onchium the amphids reduce to a strand, which passes gradually laterad, but has not been followed farther in this species. (Text Figure N.) Thus these structures homologize fairly well with the relatively few forms of amphid now known to be supplied with a plurality of terminals, presumably the ends of nerve fibers; and here, as in some other groups, the terminals are of varying character, from which the suggestion arises that, if these organs are sense organs, as they probably are, the sensations to which they are adapted constitute, within limits, a variable function in somewhat the same way that the nerve terminals of varying length and size in the human ear are explained to be adapted, within certain limits, to stimulation from a varying agent, namely, air vibrations varying from a very few up to say 40,000 per second.

An examination of two nematodes, *Trichostrongylus calcaratus* Ransom, and *Trichinella spiralis* (Owen) from the guinea-pig, kindly supplied by Dr. Ransom and his colleagues, discloses amphidial structures at the lips. It thus becomes more and more probable that there are present in all nemas, parasitic as well as free, functioning amphids, or what I suspect to be amphids; that is to say, lateral cephalic organs of extremely variable size and form, many



2.1 13. 17. 29. 52. 86. 90.5 / 2.3 3.8 4.4 6.4 2.5 0.91mm.

Fig. M.—*Cheilobus quadrilabiatus n. gen., n. sp.*—Top, front view of the lip region; followed by two successive optical sections slightly behind the lip region, one of them, the lower, through the anterior of the closed portion of the pharynx. Below, lateral view of the head.

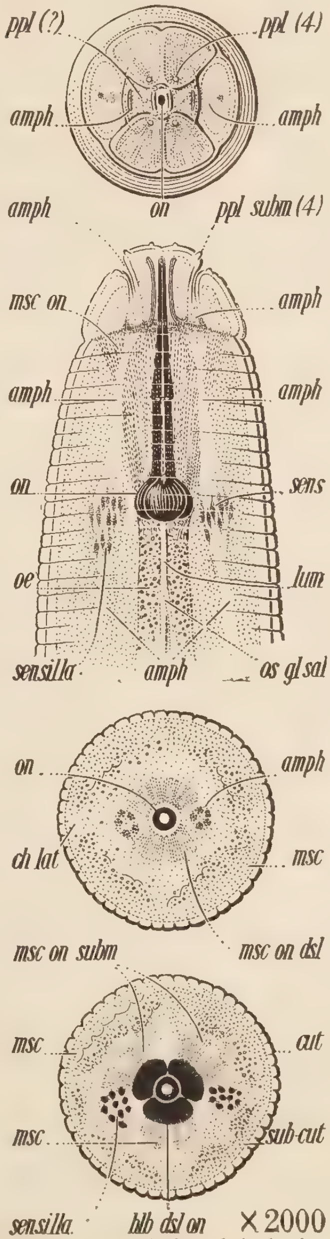


Fig. N.—Dorsal view of the head end of *Caconema radicicola* above it a front view of the lip region; below it two views looking forward from about opposite the bulbs of the onchium, and from a point somewhat in front of the bulbs.

of which are known to possess a pore through which a liquid substance can be forced out, and which in a few families are known to have lying just inside the external openings what appear to be nerve terminals, that in two or three cases are believed, on the basis of careful examination, to be connected with the central nervous system. Any one taking the trouble to examine carefully into what is known concerning the form and structure of amphids may be forgiven for doubting whether their function can at present be satisfactorily explained on any single simple hypothesis. So far as I am aware, there is no physiological evidence as to the function of these organs. If they are, indeed, homologous throughout the nematode phylum, certainly their position and the little known about their histology justify the supposition that they are sense organs connected with some fundamental necessity. If one seeks for the single sensation known with which the amphids may be most reasonably associated, it is hardly possible to avoid naming the sense of taste, or smell, or both combined, as that which most nearly fills the requirements in the case of the comparatively few amphids whose internal structure is now partly known. The amphids of the Triplonchs, so far as discovered, fit the supposition that they are organs of taste. It behooves Caconema, for instance, to know at once on puncturing a plant cell what the nature of its contents is, e. g., whether suitable food or not. A little thought will show that this achievement would be facilitated by having the amphidial openings very close to the spear, as shown in the illustrations. It is of some interest to note that on rare occasions the amphids have been found associated with other lateral organs extending back for a considerable distance. Another case of this sort has recently come to my attention, namely, lateral structures on the head end of the Agamermis larva, which appear to be modified repetitions of the amphids. This recalls a suggestion I have made in discussions before this Society, that possibly the amphids are residual cephalic members of lateral series.

Caconema gen. (aut subgen.) nov., type *Heterodera radicicola*.—The examination of the gall nema in the above careful way brings again to mind the differences in the structures of the heads and other parts of *"H." radicicola* and *H. schachtii*, and suggests the formation of a new genus, or subgenus, Caconema, for the reception of *Heterodera radicicola* (Greef) Müller, the genus to be characterized thus: Resembling Heterodera, but truly endoparasitic and less specialized in its parasitism; having the amphids protected by "cheeks;" the males with two testes, instead of one as in *H. schachtii*, the type species of Heterodera.

2. Pores in the Cuticula of *Trichinella spiralis* (Owen).—In a recent physiological work a number of rather positive statements with regard to the physiology of nemas are based on error. It is said, for instance, that the cuticula of Trichinella, not possessing pores, aids in establishing a certain physiological conception. I observe that the cuticula on the lateral fields of this species contains very numerous pores throughout the length of the body, so that the fact is erroneously stated in the work mentioned. This is not the only instance of the kind; several other statements in reputable works on general physiology with regard to excretory functions of nemas are in a similar way supported by allegations contrary to fact.

3. A Nema Parasitic in a Nema. Nemas are so rarely seen parasitic in other nemas as to make worth while the recording of all such cases. A nearly full grown larval mononch was seen to contain in its body cavity a living nema, which, on removal, proved to be a larval form of uncertain taxonomy, but probably a spear-bearing form (Mermithid). I know of only one other such observation: the very interesting one of Steiner and Heinly, where a mononch fed on Rhabditis succeeded in swallowing the Rhabditis without injuring it, the Rhabditis then boring its way into the body cavity of the mononch and escaping through the vulva, killing the mononch. In the present case, the larva is of such an exceedingly delicate nature that it seems

very unlikely that it could escape unharmed the numerous dangers it would encounter in the throat of this particular mononch (*Mononchus subtenuis*), whose pharynx is armed with a very sharply pointed dorsal onchium, two ventrally submedian onchia and a hundred or more pharyngeal denticles. It seems much more likely that, if ingested, it was swallowed enclosed in the tissues of its mother, and, being protected by the maternal tissues, reached the intestine of the mononch intact, either as an egg or larva; then developed and parasitized the mononch. The previous history of the mononch is unknown, and the exact facts of the method of parasitization can only be surmised.

4. A New Illumination for High Magnification.— Ordinarily when an image of the sun is reflected into the field of vision of the microscope its brilliance is far too great for the unprotected eye. On hazy days, however, an image of the sun can be formed *on the tissues* inside the object being examined, and, using this illuminated tissue as a source of light, things can be seen which do not come out with ordinary illumination. There are various means for duplicating the effect of the sun seen through a hazy atmosphere,— glass-walled boxes containing smoke, fumes of ammonium chlorid; water containing milk, and various other substances,—some colored. A good result may be obtained by the use of a sheet of glass very finely and slightly etched with hydrofluoric acid; *deeply colored* glass, green, blue or "daylight," may be used with advantage. With a properly modified sheet of glass between the sun and the microscope condenser, the image of the sun can be used to search the otherwise obscure spots. Should the sun's image be too bright, it may be covered inside the eyepiece by a mechanical pointer carrying a very small disc. The substage condenser should form an exceedingly small image of the source of light; a suitable condenser is an exceedingly high power microscope objective, 1.5 mm. apochromatic. Arc light is less effective than the sun.

Dr. E. C. Faust presented a brief abstract concerning: *Cleistogamia holothuriana*, a New Type of Holostome Fluke, which he had been permitted to study through the courtesy of Dr. Nelson Annandale, Director of the Zoological Survey of India. The specimens consist of several mature worms, taken from the alimentary canal of a holothurian in the region of the Andaman Islands. The fluke is a holostome since among other criteria it has a seminal vesicle at the posterior end of the body, but instead of having a typical holostomate genital pore here, there is an internal (cleistogamous) connection between the seminal vesicle and the uterus, consisting of a long chitinous (?) capillary ejaculatory duct, through which sperm pass in order to reach the uterus. The uterus, likewise, has no external connection, and it is believed that it must split open in order that the eggs may be set free. The eggs, moreover, have a long polar filament, which distinguishes them from any previously described holostome ova. Several of them are found in a fully developed worm. This species, for which the name *Cleistogamia holothuriana* nov. gen., nov spec., is proposed, is highly suggestive of one method employed by the holostomes in the transfer of the metraterm from the preacetabular to the distal region of the body. The detailed study will appear in the Records of the Indian Museum.

Dr. Faust also spoke of a reexamination of *Artyfechinostomum sufrartyfex* Lane, 1915.—He stated that after a careful study of cotype specimens kindly lent him for examination by Dr. Nelson Annandale, he was in agreement with Lane that this species differs from *Euparyphium malayanum* (Leiper 1912). He mentioned in particular the extension of the cirrus pouch a considerable distance postacetabular which, as Lane has shown, places it according to Odhner's classification in the sub-family Himasthlinae. The species must stand unless the whole scheme of classification of the echinostomes is to be overthrown.

Dr. M. C. Hall presented the following note on treatment for whipworm infestation.

Whipworms are extremely difficult to remove by means of anthelmintics, a fact due to the difficulty of ensuring that anthelmintics enter the cecum where the worms are attached and come in contact with them. Hundreds of experiments show that the worms themselves have very little inherent resistance to anthelmintics, being removed at times with even very feeble anthelmintics. This susceptibility to such anthelmintics as come in contact with them is probably likewise correlated with their position in the cecum. Of the hundreds of substances having more or less anthelmintic properties, some are taken in by mouth from time to time by man and other animals, and the worms living in the stomach and small intestine must have some resistance to these substances and be somewhat tolerant of them. However, such substances are largely absorbed in the stomach and small intestine and amounts which are not absorbed here will usually pass the ileo-cecal or ileo-colic valve and go to the colon without entering the cecum, or enter it in very small amounts. In consequence of their protected situation, whipworms have little opportunity to develop a resistance to drugs and actually have little resistance. Owing to the difficulty of ensuring the entrance of anthelmintics into the cecum, the subject of treatments for whipworms has received much attention and these worms appear to have been attacked in a greater variety of ways than any other of the parasitic worms. In addition to the ordinary methods of treatment by the usual anthelmintics, the following methods have been used: Repeated daily doses of some nonirritant drug of relatively low toxicity, such as santonin, to ensure the ultimate entry of some of these doses of the drug into the cecum; the use of single massive doses of an anthelmintic of relatively low toxicity, such as the latex *Ficus laurifolia,* to ensure the entry of part of the dose into the cecum; the use of rectal injections, the use of intramuscular injections; the use of intravenous injections; and surgical removal of the appendix in man or the cecum in dogs. Apparently whipworms may be removed by all of these methods, but it does not appear that the use of any drug by any of these methods is yet satisfactory.

Dr. Bartsch emphasized the importance of studying the microscopic structure of organisms as a basis for classification, citing examples from the field of mollusks.

C. W. Stiles, *Secretary.*

BOOK REVIEWS

FILARIASIS IN BRITISH GUIANA

The report of the Filariasis Commission of 1921, forms volume 5 or Memoir 7 of the Research Memoir Series of the London School of Tropical Medicine. The main part of the work is taken up with a report on the clinical, pathological and therapeutic investigations by Dr. John Anderson. The work contains an immense amount of interesting and important material. It furnishes abundant evidence of the magnitude of the problem and the vigor of the attack on it made by the Commission. They found that practically one fifth of the inhabitants harbor *Filaria bancrofti* and that the infection is primarily urban. No evidence of racial immunity was obtained. Filarial lymphangitis is very common and the proportion of sufferers from elephantiasis is higher in Georgetown than in any other city in the world. In the opinion of the writers all the pathological manifestations associated with filariasis are due to secondary infection by pyogenic organisms and can be treated with effect by antiseptic measures and by injection of specific vaccines; yet the total eradication of the disease depends upon prophylaxis and the complete banishment of the mosquito, *Culex quinquefasciatus,* from the dwellings of the people. Careful study of postmortem materials shows that both in cases that died during the day and in such as died at night the kidney tissue harbors by far the largest number of microfilariae and 5 times as many during the day as at night. This was also the proportion in most other organs altho they contained smaller absolute numbers; in the lung which next to the kidney showed the largest content of microfilariae there were fifteen times as many by day as during the night. *Filaria ozzardi* was found in the aboriginal Indians in northwest British Guiana, but no *Filaria bancrofti* and no elephantiasis. Twenty-three valuable plates illustrate the memoir but the explanation for them is so well hidden that it was only discovered by accident.

PRÉCIS DE PARASITOLOGIE HUMAINE (Parasites animaux et vegetaux, les bacteries exceptées). Par P. VERDUN, et A. H. MANDOUL, 3rd Edition, 950 p., 434 figs. et 4 pl., in color.

The appearance of this new edition after a lapse of 12 years since the second was printed demands more than passing attention since the series known as Collection Testut occupies a unique place in making a definite appeal to students of medicine and handling those matters both theoretically and practically which are the particular subjects of the examination for the doctorate. The present edition has been so largely expanded that it partakes of the character of a new work although conforming in general to the plan of the series.

The various parasites are treated according to their location and especial emphasis is naturally placed upon the medical aspects of the problems of parasitology. In general, recent work in various groups has been adequately considered and incorporated into the text. The clinical determination and differentiation of the particular species has been given especial attention, and characteristic features that may serve for microscopic diagnosis are brought out by the use of italic type. Under the various headings some emphasis is laid upon means for the cure of the disease and for its elimination from infected territory. The destruction of flies, mosquitoes and other insects, the elimination of rats, and similar problems that play a large part in actual public health measures in infected regions have been unusually broadly and fully discussed.

It is most unfortunate that the zoological aspect of the work it not quite as good as the medical. The system of animal classification employed is not at all up to date and not equal to that found in other works of the present day. It is difficult to justify the incorporation of ancient names, however honorable their origin and history, after they have been generally discarded by working parasitologists. Some of these features are relics of the former editions and various smaller parts of the book might have been discarded or worked over more thoroughly to the advantage of the text as a whole. Some old cuts are very poor, and it is unfortunate that there might not have been more illustrations like the splendid microphotographs by Professor Verdun that have frequently been utilized. Now and then one finds evidences of carelessness or haste as in the constant misspelling of the name of the distinguished helminthologist Looss, and also of scientific terms. The work is well illustrated on the whole and the colored plates are especially well executed.

ATLAS DE PARASITOLOGIE. Par le Dr. Paul Hauduroy, préparateur a la faculté de médecine de Strasbourg. Librairie Octave Doin, Paris, 1923. 25 planches en photogravure.

The idea of the author deserves high praise as he seeks to present in simple form the actual appearances which a student would meet under the microscope in an examination for human parasites. The plates cover a wide range of animal and plant parasites, and are for the major part well done tho it seems unnecessary to devote an entire plate to three temperature curves of malaria. Some figures like those of certain worms are too diagrammatic and not truly representative of those species. Careless proof reading has left unfortunate and striking errors in a few names, and such blemishes are unfortunately conspicuous. The work should certainly be revised in minor details and reissued for it meets a real need and stands alone in this field.